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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Differing Views on Dues

APROPOS of our recent notice of the formation of the Indian Society of Engineers (p. 840, Oct. 30-Nov. 6) and of the comment on p. 846 of our last issue on the report of the Committee on Development of the American Society of Civil Engineers, a word is warranted on the dues of the new body in India. With a very few, if any, exceptions all the members of the new society are members of the leading English or American technical societies, and accordingly pay their annual dues and have paid their initiation fees. Yet in joining the new body they must pay admission fees of $67 (200 rupees) for members and $33 (100 rupees) for associate members, with annual dues (payable quarterly) of $20 and $16, respectively. Yet we place dues for national civic and welfare work at $1.50 per member. This low fee is set, it is true, as a beginning, but the significant feature is that the Indian society at its very beginning has viewed the matter quite differently.

Toronto's Water Filtration Experiment

THE third stage in Toronto's huge water-filtration experiment will afford the crucial test. Acceptance of the plant from the contractors after a long delay was the first stage. The second is marked, so far as interested outsiders are concerned, by the favorable report on the physical operating results given in the paper abstracted on p. 822 of our issue of Oct. 30-Nov. 6. The publication of data showing what it costs to treat a million gallons of water by the drifting-sand process will be the third stage. The cost data should take into account whether the amount paid by the city yielded the contractor a reasonable profit and if not how much of the deficiency should be charged up to the development of the process—to be recouped from other cities later on. The cost data should also include an ample allowance for the depreciation on any portions of the plant that must still be considered experimental and thus subject to replacement or heavy repairs.

Should Cities Take Such Risks?

TORONTO'S huge experiment noted in the foregoing paragraph and the ventures in sewage treatment apparently about to be made by New Jersey and Pennsylvania municipalities make it pertinent to raise the question, "Should cities take such risks?" So far as appears, Toronto made a contract for a water filtration plant of a relatively untried type on the assurances gained from the operation of a small working model at Toronto and reports of a few small working plants abroad, but without the advice of a single disinterested engineer versed in water treatment. Phillipsburg, N. J., and Allentown, Penn., propose to expend what for them will be large sums of money on a method of sewage treatment still so much in the experimental stage that the respective state departments of health have given only conditional approval to the plans, if indeed the New Jersey permit can be so characterized. Toronto, Phillipsburg and Allentown thus become partners in the risk attendant upon developing new processes. Is this a wise municipal policy. True, if someone besides the promoter does not join in the risks attendant on a new process then progress will be slow or nil. But this only raises the further question; Under what conditions should a city accept such risks, or how great risks of the sort should it assume? We will not attempt an answer further than to say that as a rule no material risks of the kind should be taken by a city without the approval of a competent, disinterested engineer.

Flying in the Face of Precedent

THE risks noted above have considerable engineering interest because they fly in the face of precedent and ignore sad experiences elsewhere. Thus, as regards the drifting-sand filters at Toronto, those who have watched the development of mechanical filtration will remember the battle royal between the early mechanical filter companies over the necessity of pre-coagulation and the disaster that befell one of the companies through installing a plant without pre-coagulation at New Orleans. True, it is a far cry between New Orleans and Toronto in distance, time, and character of the water, but in the long time-interval and the vast range of experience meanwhile recorded, the desirability if not imperativeness of pre-coagulation seemed to have been established. Is Toronto to show that, for some waters at least, pre-coagulation is unnecessary, even with an unusually high rate of filtration? Turning now to sewage treatment: For two decades or more the great effort has been to reduce the volume of sludge. On this and other accounts, chemical precipitation plants have been abandoned right and left. For three decades attempts to treat sewage by electrolysis have been made in America and in Europe—and there are today only a very few of the kind in operation and those of doubtful utility, while one has been scrapped at Danbury and two, of another type, at Oklahoma City. In the face of such a record, two cities within a short period have taken steps to provide themselves with plants that combine lime treatment and electrolytic action with some thousands of revolving paddles, and that against the advice of their state authorities! If this is not a partnership in experimentation and a flying in the face of experience, what is?

Standard Concrete Beam Sizes Wanted

NOT long ago a well-known contractor found in going over the drawings of a concrete factory he was about to build that there were upward of one hundred different sizes and details of straight beams and girders. Before the building was started his engineers managed to persuade the architect to accept changes in details which reduced the number of different beams to one-quarter of those in the original design, with a consequent saving in time, effort and money, a saving which would have been greater still had the standardization been studied out in the first place. Though this is probably an extreme case, there is altogether too much variety in concrete designing, too much effort to make the theoretical resisting moment precisely the same as the bending moment. If, as in structural steel practice, there were a sufficient number of accepted standardized sections with graded resisting moments, the saving in design and construction costs due to the greater simplicity of using the standards would undoubtedly outweigh the extra material required because of the variation between stock-size resistance and designed moment. If at the same time some qualified body recommended such a standardization they could also reduce the number of sizes of steel reinforcing bars normally used, they would render a great service to the concrete building industry.

The Churches and Labor

AN INTERESTING development in the current consideration of labor problems is the recent participation of the churches in the discussion. The Interchurch World Movement, an organization of Protestant denominations, some time ago put forth a social program and in November presented a memorandum of nine principles to the International Labor Conference, sitting in Washington. Last year the Catholic bishops of the United States enunciated a program, and one or two other religious bodies have openly advocated an advanced handling of the industrial situation. To our mind this is a good augury. We have no sympathy with the business man, who, when asked to aid in the industrial survey conducted by the Interchurch World Movement, replied that his business "was no Sunday school." Our churches have preached the doctrine of personal righteousness and of justice to our neighbor, but applications of general principles have been left to the individual. Evidently the need for becoming concrete is impressing itself on church leaders and they are now making the application of the principles to the problems of the day. The entry of the churches adds another strong champion to the ranks of those who are contending for social justice. They will bear influence in quarters not reached by other media. While this entry is belated, we hope that it will be followed with vigorous and sustained action. The mighty educational campaign now in progress needs all possible support.

An Old Problem to the Front

SOME day a commercially practicable process of recovering valuable products from sewage may be perfected. Thus far there is little but hope to go on. The difficulties of degreasing and dewatering sludge are presented on p. 948 of this issue, together with an outline of the methods and possibilities of adopting the Cobwell system of garbage treatment to sewage sludge.

No glittering promises of revenue are made by Mr. Wells. For the present, at least, he sees no likelihood of recovering either grease or fertilizer base of a sufficiently high grade to induce manufacturers to pay money for it, although they might take it away without charge. Some cities are so placed that even this might be an object, and the number will increase with the growth of urban population and of the demand for environmental amenities.

The altruistic motive of conservation of wastes, suggested by Mr. Wells, is not likely to appeal to many cities unless they can find no cheaper tolerable method of sludge disposal than converting it into grease and fertilizer base—to be given away. It is conceivable that ultimately society as a whole might finance sewage disposal as a matter of conservation; but would it be any more practicable for a state or the Federal Government to treat sewage for conservation purposes than for a city to do so? In the last analysis, the cost falls on the ultimate consumer. He will get no benefit from the recovery of grease and fertilizer base from sewage unless those materials can be produced as cheap or more cheaply that way than otherwise. When scarcity demands the use of as low-grade products as sewage-sludge grease and ammonia then the manufacturer can afford to pay cities for them.

If, however, Mr. Wells means that manufacturers may yet take the wet sludge without charge, that is quite another matter. Conceivably, the time will yet come when the grease and fertilizer interests will locate recovery plants at sewage-works, take sludge just as it comes from the tanks, and send the crude grease and fertilizer base to central refining and utilizing plants. At the start, cities might well pay for the service, with hope of early relief from payment and ultimate revenue.

In any event, Mr. Wells' paper is a notable one. His plea for hearty coöperation in the further study of sewage utilization possibilities deserves the attention of engineers, chemists, public authorities and the grease and fertilizer interests. The time for such coöperation was never more opportune than now.

The Architects of Buffalo

A VERY striking example of disinterested service to the public by a group of professional men—the most striking we can recall in the construction professions—is afforded by the manner in which the architects of Buffalo are carrying forward the building program of the Board of Education. The program included the alteration of three buildings and the construction of 15 new ones, at an estimated cost of $8,000,000. The purpose is well put in the words of the secretary of the Associated Buffalo Architects, Mr. Duane Lyman: "The architects of the city were of the opinion that an organization of the local profession, which would indicate a real capacity for a sympathetic and intelligent interpretation of the policy of the Board of Education, as well as insure a well considered application of the best experience among them, would lend itself to an effective and creditable execution of this school program, creditable not only to the Board of Education and the city of Buffalo, but to the architectural profession as a whole, and that the use of such an organization would eliminate much waste motion when compared

with the execution of the work by many individual architects."

In the spring of this year Mr. William B. Ittner, of St. Louis (note that a consulting architect was brought in from the outside), was retained by the Board of Education as consulting architect, and at a somewhat later date the architects of Buffalo, who had in the meantime formed a membership corporation known as the Associated Buffalo Architects, Inc., were retained to execute all of the architectural work of the entire program, with the exception of the part carried out by Mr. Ittner.

The purpose of the corporation is to obtain for the city the most satisfactory and rapid execution of the work and the best results possible in the buildings in question and to make the results obtained the collective achievement of the entire membership. Since many of the plans are to be identical, or at least very similar, the original or key plans will be prepared in a central office of the corporation, the member officers carrying out the remainder of the work in accordance with standardized data and details. The preliminary drawings and data for many of the buildings have been prepared by Mr. Ittner and approved by the Board of Education, and the actual execution of the architectural work is now in progress.

Summing up the situation, Mr. Lyman says: "The members of the Associated Buffalo Architects, Inc., feel that they have a rare opportunity through this plan to be of vital service to the community, and at the same time to improve the standing of the architectural profession in the minds of the public and to emphasize the value of architectural service."

We have long looked with admiration at the breadth of vision and the effectiveness of action displayed by the architectural profession in its organized procedure. Here is additional evidence not only of ability to cooperate effectively, but of a clear-cut and compelling conception of the obligations of a profession to the public. At Buffalo there were eighteen plums that might have been scrambled for. Professional obligation, however, was controlling rather than selfish interest—an example that may well be preached to all professions.

Capitalizing the Engineering Urge

WHATEVER are the pedagogical advantages or shortcomings of the so-called case system of teaching engineering, it has a very human appeal to the engineer who remembers his student days. Those engineers who do not appreciate this should read the report on the teaching methods at the Engineer School at Camp Humphreys, just issued by the Committee on Education and Special Training of the War Department. They will find, for instance, instead of the oldtime dry-as-dust text study of a uniplanar bridge truss, with its months of preceding study of force lines and load arrows, that the student of structures—in this case boys who had passed the two-year emergency course at West Point with only an elementary study of science—approaches first a living bridge and through a series of graduated questions is led by the instructor to consider it not merely as it has been to him before—a part of the landscape—but to see it with an engineering eye as a structure to carry a familiar load. Here is some life put in the dull business of study, some recognition early in the game of the ultimate field of the engineer as a designer and builder.

To those of us brought up on the old deductive method of teaching engineering the thing seems impracticable. How can a boy who never heard of the moment of inertia comprehend the design of a plate girder? What does uplift and overturning in a dam mean to one who does not understand the equation of moments? The answer is that at Camp Humphreys the scheme works and that the deduction of principles came readily enough from the structural facts. Astounding progress in sound engineering thinking is made.

But, it will be said, at the Army school the case system was an invention born of necessity. Engineering principles and methods had to be driven home to men grounded only in the fundamental engineering sciences. Every student officer had ahead of him the goal of the commission and the supreme urge of a present war. His mind had been rendered sufficiently agile to dispense with many of the intermediate steps of conventional instruction. There was no need to drive him to his studies. In other words, motivation was high.

All this is true. To develop the system in times of peace some other motivation must be sought, something beyond the mere desire to pass the course, which is at best a tenuous appeal. That something does exist, and it may be that it can be utilized by the deductive method of instruction. Practically every boy who goes to an engineering school does so because he wants to become an engineer, because there is something appealing to him in the profession. Few go because they figure there are riches in it; the occasional one who is driven to it against his will will soon drop out or will not count. The great majority, however vehemently they would deny it in public, are attracted to what for want of a better term we may call the romance of engineering. They want to build things; to see materialize under their own hands the structures and ideas which they themselves conceive.

This half-formed desire for expression is deadened by the long grind of technical-school instruction. Far, far ahead of them are the things they want to do; meanwhile they must work with the detail and the theory on which the completed structure rests. Long ago the pedagogues recognized this lack, but they went about supplying the application by way of illustration of theory rather than as the primary impulse of their courses. To the practicing engineer now who remembers the dreams of his early school days there seems to be a chance to utilize this groping after engineering knowledge as the motivation of this instruction.

Details are for the teaching expert. The profession will watch their development with more than ordinary interest. Camp Humphreys, to be sure, is turning out engineer-officers who admittedly do not have to be as thorough in detail as they are sound in principle. In the words of the report "the courses aim to lead the student to think out a decision in the face of a real situation." It is a fair assumption that details and principles are of equal importance to the civilian engineer, and the Humphreys system has not proved that it can guarantee their equal development. It has shown, though, that while there may be no royal road to learning, the ordinary traveler may in places pick out a scenic highway instead of a tunnel. In its beginnings it is entitled to serious consideration for that if for no other reason.

Concrete Shipping Pier at Panama Has Novel Design

Scarcity of Steel Leads to Long-Span Concrete Alternate Arches and Beams for Longitudinal Members of the Latest of the Four Terminal Piers at Cristobal

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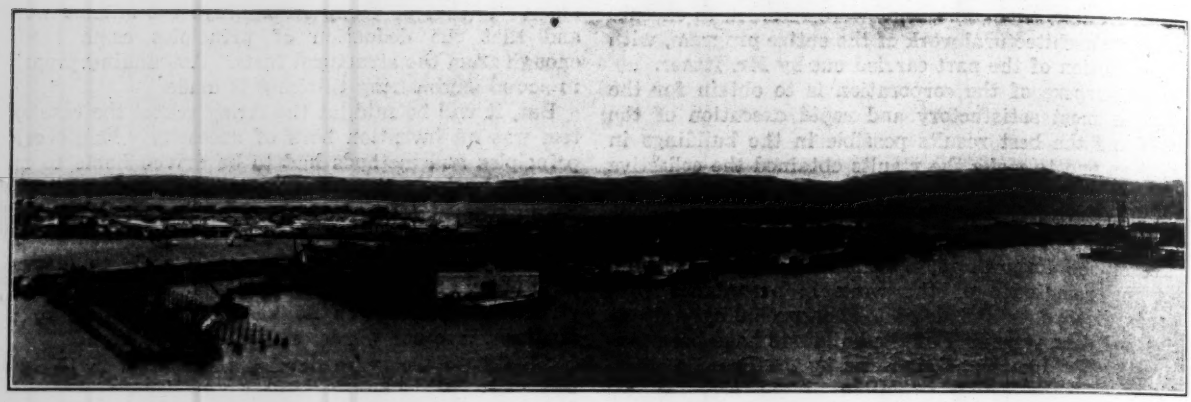


FIG. 1. CRISTOBAL HARBOR WITH PIERS 6, 7, 8 AND 9, IN ORDER, LEFT TO RIGHT

STEEL scarcity on the Panama Canal during the war was such as to cause a radical change in the design of Pier 6, the latest of the shipping piers at Cristobal, one of the entrances of the canal. The foundations of this pier were placed for a long-span steel superstructure similar to those already erected, but by the time bids were asked steel was so high in price and deliveries were so uncertain that a concrete design was substituted. This consisted of alternate tied arches and beams spanning longitudinally the already placed pier footings with concrete cross-beams and deck. Both in computation and construction the pier presented enough novelty to warrant its description.

The natural growth of shipping since the canal was first opened to traffic in 1914 has resulted in a steadily increasing demand for terminal facilities, at both the Atlantic and Pacific entrances. Although there is a possibility, especially with the extension of South American trade, that the isthmus may be the logical place for storage warehouses, thus far the major function of the piers has been as a transfer point for freight, as it is uneconomical for smaller-sized vessels to pay tolls through the canal when cargo is less than a maximum. The port of Cristobal is especially favorable for pier construction in so far as tidal difficulties are concerned, for there is ordinarily less than 18 in. difference in elevation between average high and low water. On the other hand, the foundations have required considerable care both in construction and design, due to the nature of the subsoil and final distance to rock.

Three piers, Nos. 9, 8 and 7, have been built in Cristobal harbor, and the latest, Pier 6, is now under construction. The three completed piers have the same general characteristics of construction; namely, foundations of concrete cylinders to rock, structural-steel floor system incased with concrete for protection, and structural-steel shed. Details have slight variations, but the essential layout is the same in each case.

Due to the poor character of the subsoil as a foundation and the well known temporary character of wooden piles in tropical waters (owing to the action of the teredo), it was decided to drive steel cylindrical shells or caissons to rock, excavate, and fill with concrete. These caissons were composed of $\frac{3}{8}$-in. thick material in building the first three piers. The diameter of the caissons was increased from 4 ft. on the first construction to 6 ft. on Piers 8 and 7—this change, incidentally, proving to be more efficient in the use of material.

Serious construction difficulties, however, had previously been encountered, due to leakage when excavation was done, and collapse in certain instances. Seven cylinders collapsed on Pier 7. It was noticed that these failures occurred only when the shell had been distorted from its circular shape to that of an ellipse, and that the majority of the failures was not at the base of the cylinders, as would naturally be expected, but at depths varying from 70 to 90 ft. Total depths of the cylinders themselves varied from 75 to 127 ft. Calculations made, assuming a hydrostatic pressure of 100 lb. per cubic foot, showed that failures should occur in a 6-ft. diameter shell of $\frac{3}{8}$-in. material if the diameter was $1\frac{1}{4}$ in. greater or less than theoretical. Since some of the caissons were successfully driven and excavated to a depth of 120 ft. whose axes were 56 x 9 in. and 66 x 3 in., respectively, when stress calculations indicated that the fiber stress for such a section was several times beyond the elastic limit, it was apparent that other forces entered into the analysis that had evidently been neglected. An inspection of the chart made from borings revealed the fact that all failures occurred at the same elevation as a stratum of quicksand through which the caissons had previously been driven.

The most plausible explanation appeared to be that the passive pressure developed by the hard material kept the line of thrust within the steel shell, and very little bending, if any, resulted even when the circular section had been subjected to considerable distortion. This theory was, of course, corroborated by all failures occurring in the stratum of quicksand, which, as is well

known, is a material that develops very little passive pressure.

The caissons for Pier 6 were accordingly designed with the foregoing theory in mind, and special care was taken to maintain the circular section where quicksand was to be expected. The material for the caissons was accordingly $\frac{5}{8}$, $\frac{1}{2}$, and $\frac{3}{8}$ in. thick, the heavier material being used at the lowest depths. As a result of these precautions, no failures occurred in driving the caissons in Pier 6.

As stated, it was originally intended to follow practically the same designs for the floor system of Pier 6 as for Pier 7, and accordingly construction was started on the foundations a short time prior to the advertising of bids for the structural steel. When the bids were opened it was found that the total of item for structural steel was $639,000, as against $250,000 for similar material on Pier 7. Although a slight increase in cost had been anticipated, it was felt that the enormous excess did not fully justify the further consideration of structural steel if a possible saving might be effected by the use of concrete.

Scarcity of ships, in addition to the congested condition of the structural steel fabricating plants in the United States at that time, caused the bidders to state that no definite time of delivery could be guaranteed. The matter was therefore held in abeyance until investigations could be made of the feasibility of a reinforced-concrete floor system.

As sufficient cylinders had been driven to preclude any possibility of changing the original spacing (which was 45 ft. longitudinally and 26½ ft. transversely), this predetermined spacing, together with the live load of 750 lb. per square foot, made the proposed design a rather critical procedure. Naturally, the first method considered was to use continuous concrete girders longitudinally and smaller T-beams transversely. The span of these girders was 45 ft. and the approximate section 10½ ft. deep and 4½ ft. wide. No method of supporting the forms for girders of such unprecedented size and weight could be devised at that time, as the only apparent place to support the forms was on the cylinders, and the girders themselves were to be poured on the top of the cylinders, leaving but a few inches on each side to be used as a support. Piles could not be used on account of their excessive cost, as the average depth of water was about 41 ft. It was also desirable from the standpoint of continuity, to pour more than one span at a time, and this further complicated the difficulties of supporting the forms. The vertical construction joint over the cylinders also appeared to be an objection, as it would tend to open when the spans were fully loaded, and previous experiences in this climate showed that a possible deterioration of negative-moment steel might ensue even though attempts were made to protect it. In view of these difficulties, it was considered unwise to attempt such a type of construction, as the success of the project depended upon the solution of numerous details, the cost of any one of which might be unduly excessive.

An ingenious method was then proposed; namely, of alternating arches and girders for the main members, using the small floor-beams practically as before. This design, which required a steel tie-rod in each arch, had certain construction advantages. The forms for the arch could be partially supported on the tie-rod. The unit of pouring could be one girder and two half-span arches. The construction joint at the crown of the arch would be in compression for maximum tensile stress in the tie-rod, and secondary stresses due to pouring half arches would be small. In the preliminary design it was attempted to use a girder of variable moment of inertia which would be similar in appearance to the arch, but this design showed unfavorable conditions of reversal of stress under certain loadings, and the haunched girder, as indicated in Fig. 3, was eventually adopted. The estimated cost of this type of construction was greater than continuous girders of reinforced concrete but less than that of the proposed structural-steel design, the choice being governed mainly by construction requirements.

A general plan of the entire pier is shown in Fig. 2 and a typical cross-section is indicated in Fig. 4. The arches and girders beneath the railroad tracks were designed for a live load of two cranes, spaced 45 ft. on centers, weighing 87 tons each and carrying a load of 68 tons per crane. These highly concentrated loads gave slightly smaller results in both moment and shear than was produced by the uniform live load of 750 lb. per square foot adopted elsewhere.

The triangular end is of the usual type of beam-and-girder construction. No great difficulties were en-

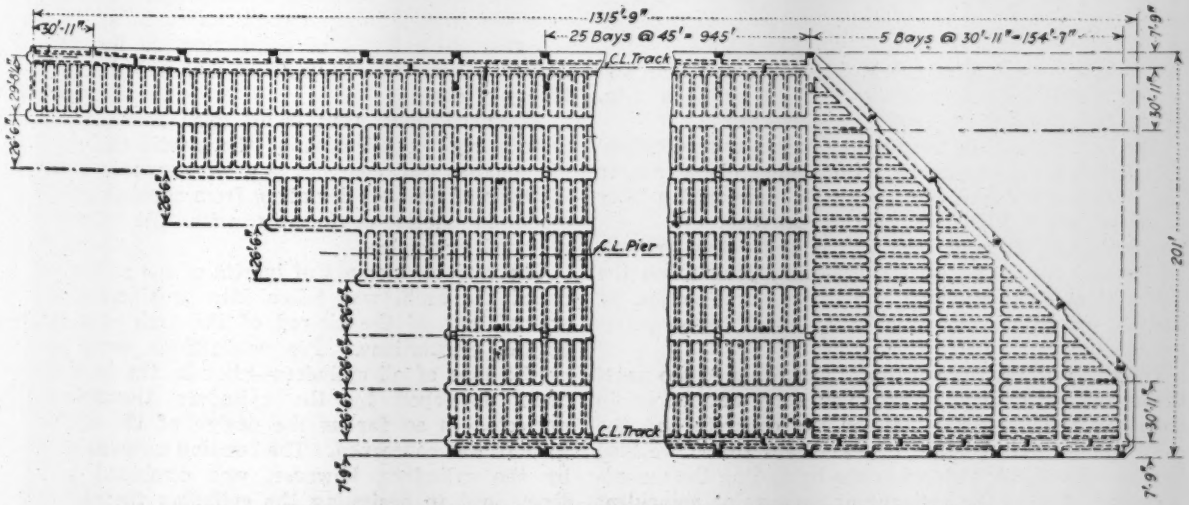


FIG. 2. GENERAL PLAN OF PIER 6 AT CRISTOBAL HARBOR, PANAMA CANAL

countered in supporting and pouring these girders, as the span lengths were not excessive. The forms were supported by trussed beams floated into place, which in turn rested on temporary steel brackets fastened to the cylinders. These brackets were removed after the completion of each girder.

A typical arch-and-girder unit of the main portion of the pier is shown in Fig. 4. The reinforcing consists mainly of 1¼-in.-diameter rods lapped in the diagonal portion. It will be noted that the construction joint at the crown of the arch is capable of taking either a positive or negative shear. The short rails in the joint were not included in the calculations, but were placed as an additional factor of safety. The steel tie-rod is composed of eight angles, 6 x 6 x ⅞ in., and two web members, 24 x ⅝ in., securely latticed by 2½ x ⅜-in. lattice bars.

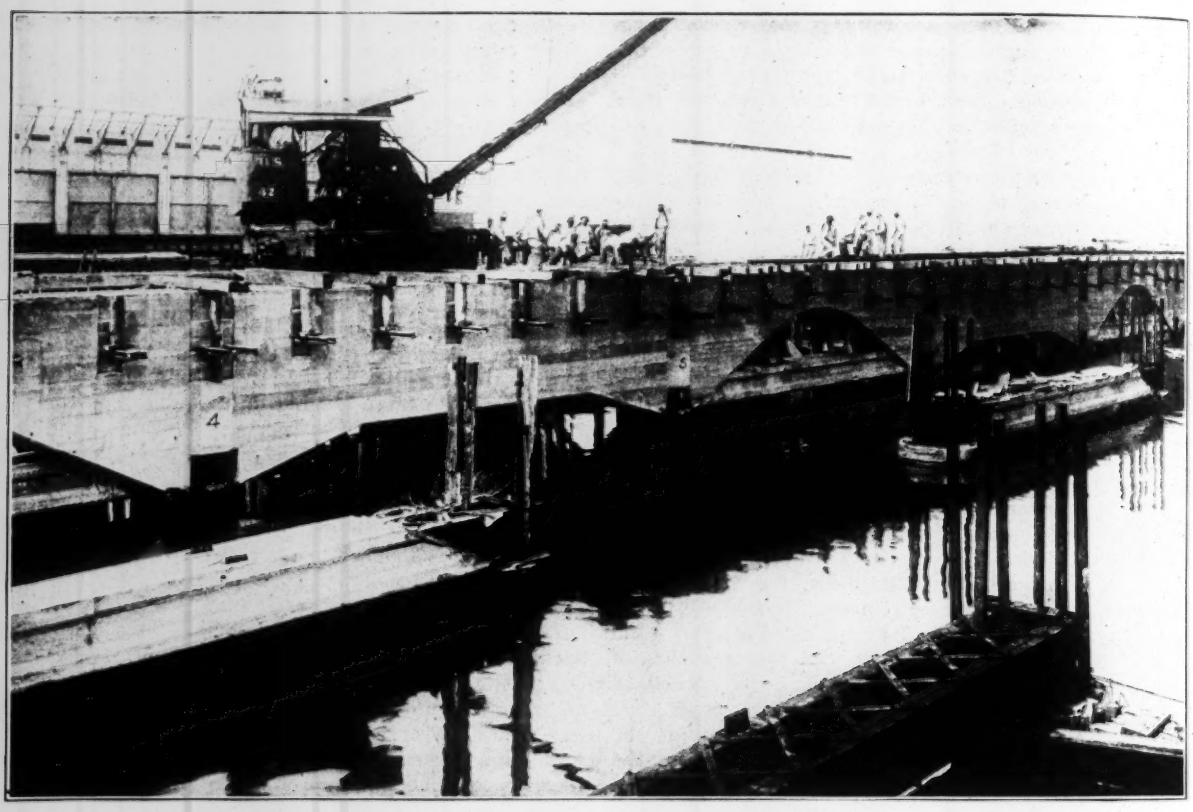


FIG. 3. MAIN LONGITUDINAL GIRDERS, PIER 6, CRISTOBAL, UNDER CONSTRUCTION

The horizontal rails over the cylinders were obtained at a low cost on the isthmus and, being placed nearer the neutral axis than the steel rods, developed a fiber stress of about 12,000 lb. per square inch.

Calculations showed that if one unit—that is, one girder and two half-span arches—were poured and the forms completely removed, the loss of arch action by such a procedure was sufficiently small to be disregarded.

The cross-beams were designed according to the usual theory of continuity. Particular care was taken to keep the bond stresses between the concrete and the steel low in that portion of the beam that developed negative moment. This was done by finding the magnitude and sign of the moment at each point coincident with the maximum shear found to exist at that point. Since this type of structure was anything but standard, the usual formulas for arch analysis, as given in the standard American textbooks, were not sufficient. Its exceptional character and cost, and repetition of each unit, together with the possibility of overloading the completed structure, seemed to justify calculations of more than the ordinary degree of accuracy. It was accordingly decided to obtain the best analysis possible, by a rigid application of the theory of elastic deformation.

The analysis of a structure of multiple indeterminateness requires certain assumptions to bring it within the reasonable limits of calculation, so the following general assumptions were adhered to in building up the theory of design:

All calculations were based upon formulas derived from a rigid application of the elastic theory, which presupposes that concrete is a homogeneous substance. Methods of analysis deviating from usual practice were made in strict conformity with the above-named accepted principles.

The variable moment of inertia of the girder, as well as of the arch, was taken into consideration. The extensibility of the tie-rod of the arch was included in the calculations. Pin connections were assumed at the tops of all cylinders—that is, the bending moment developed by the cylinders themselves was neglected in so far as the design of the arches and girders was concerned. The bending moment developed by the cylinders, however, was combined with the direct load in designing the cylinders themselves.

Stresses due to rib-shortening were neglected, because a rough calculation showed that these stresses would be balanced by the tendency of concrete incasement around the tie-rod to reduce the elongation of that member. The stresses in the arch and girder, due to settlement of supports because of the shortening of the cylinders under direct load, were also neglected. The usual assumptions in the beam theory, as recognized by current engineering practice, were followed.

The influence of a load on any span has been considered to extend over two spans on each side of the loaded span, or a total of five spans. This assumption necessitated calculations for a structure indeterminate in the seventh degree, the redundant conditions being moments over four supports and stresses in three tie-rods.

A brief review of the method of calculation of stresses may be of interest, as it was somewhat different from the usual manner of applying the elastic theory. The five-span structure considered was assumed to be cut by vertical planes over the four intermediate supports. This separated the structure into simple beams and two hinged arches. The solution of the two-hinged arch did not present many difficulties, as existing formulas could be easily adapted and applied. The angular deflection (or destortional rotation) for various types of loading was obtained for each end of the loaded span. The angular deflection at each end of every span was then calculated in terms of M, wherein M was a moment externally applied at one end of the span in question. This proved to be comparatively simple in considering the beam, but the two-hinged arch required the derivation of a formula which showed the relation between the horizontal thrust in the tie-rod and the moment M. Finally, the unknown moments over the four interior supports were calculated from the fact that the final angular change produced at any support is the same when the moments on the girder on either adjoining span are considered. In other words, the ends of two girders continuous over any support undergo the same angular change at that support. Two analyses were, of course, necessary, one with the arch as a loaded span and one with the girder as the loaded span.

The visualization of the moment areas involved will be aided by reference to Fig. 5, on which is indicated the manner in which the moment areas should be subdivided for a continuous beam of five spans.

The cylinders and the floor system of Piers Nos. 9, 8 and 7 were constructed by means of locomotive cranes supported on temporary trestles. Four trestles, each approximately 1000 ft. long, were used in the construction of Pier 7. The high cost of piling meant that the cost of this type of preliminary construction would be abnormal on Pier 6. For this reason the scheme adopted on Pier 6 was to use one trestle through the center line of the pier, and floating derrick barges for the outside portions.

The caissons were driven by means of a steam hammer, and excavated with an orange-peel bucket. Excavation at the bases of the cylinders was accomplished by hand labor, and the material was removed by means of a small hoisting engine. Two cylinders of average length could be poured in a little over one day.

In concreting the arches and girders, more care was required. The time of pouring and the possible deflec-

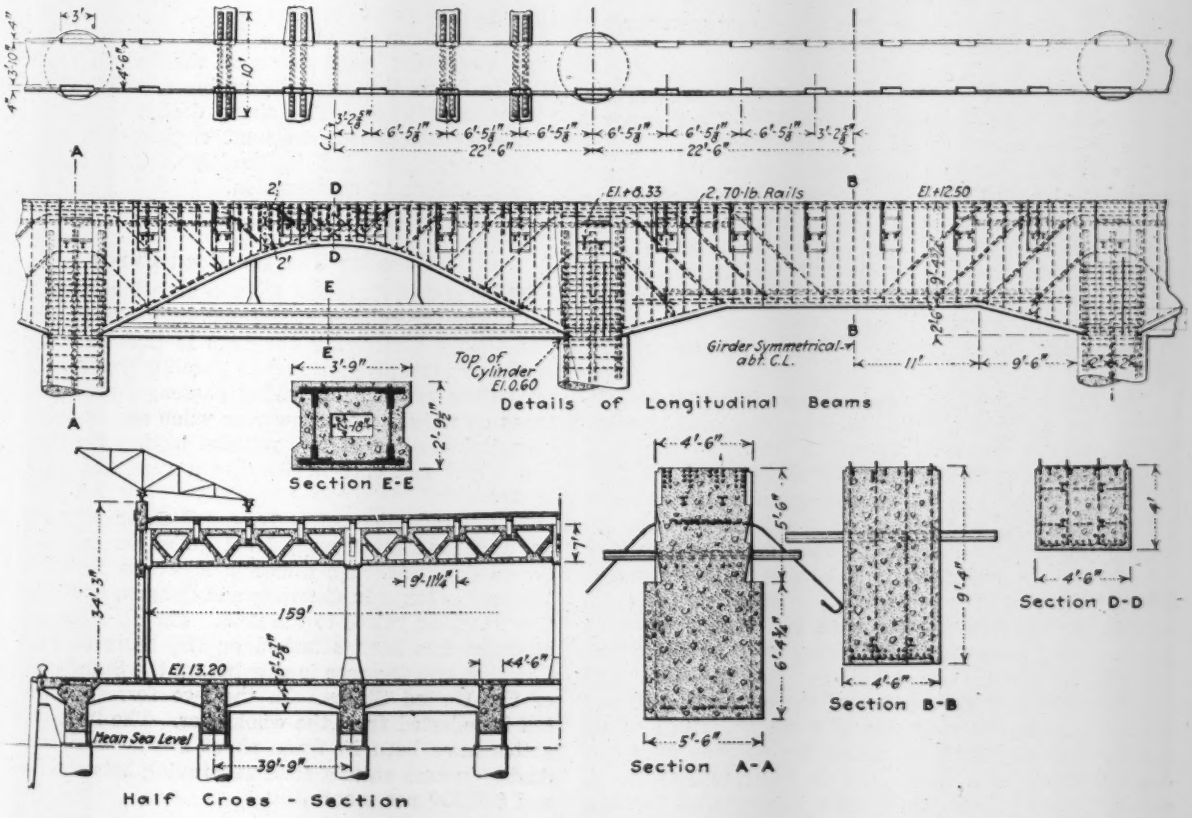


FIG. 4. DETAILS OF REINFORCED-CONCRETE PIER 6, CRISTOBAL

tions of forms before concrete was entirely set, in addition to the possible introduction of secondary stresses due to the manner of supporting the forms, demanded especial care and close coöperation of field and office. The tie-rods were first erected and then incased in concrete. Second-hand steel girders were obtained for supporting the forms for the heavy concrete girders, and rested upon 18-in. Bethlehem H-beams, which in turn were partly supported by adjacent cylinders and were normal to the second-hand girders themselves. The increased tie-rod itself served to assist in supporting the smaller steel beams which held in place the forms for the arch. The reaction for these small beams was placed near the ends of the tie-rod, to avoid deflection of that member and consequent introduction of secondary stresses at its ends.

The original requirements were obtained by this

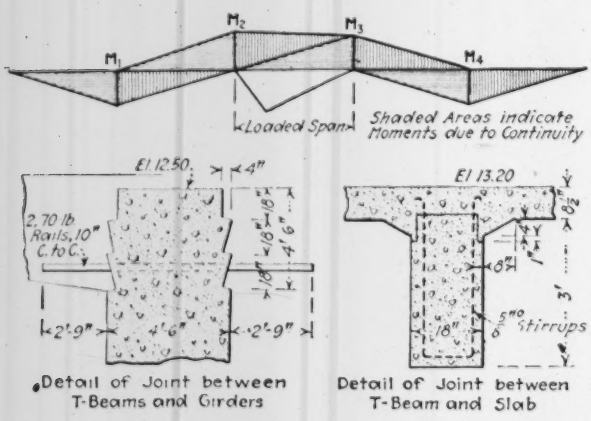


FIG. 5. SOME DETAILS OF DESIGN AND CONSTRUCTION ON CRISTOBAL PIER 6

method of supporting the forms, as field measurements of deflection were found to be negligible. Furthermore, the complete outfit of forms could be dismantled and set up again in a comparatively short time. Each form was used about 16 times during the course of construction of the floor system. The unit of pour was one girder and two half-span arches, which together consisted of 130 cu.yd. of concrete. After the completion of the arches and girders, 18-in. Bethlehem H-beams were placed transversely across them and from these H-beams the forms for the T-beams were suspended by wires.

The great weight of concrete when the slab and T-beams were included with the arches and girders precluded any possible attempt to pour all together, and since any type of connection that raised the final elevation of the pier 13 ft. above sea level could not be considered, it was evident that a joint between the supporting girders and the T-beams must be developed that would be sufficient to take the entire reaction without danger. The joint finally adopted, as indicated in Fig. 5, was chosen after tests had been made on a small model, wherein the efficiency was so high that it could practically be considered 100%. Its chief advantage is that the section of the supporting girder suffers a negligible reduction of strength, which would not be the case if the bases of the notches were not directly above each other. As an additional factor of safety, however, two short rails were placed through the main girders, which tied the T-beams together laterally and was, as well, of assistance to the concrete notches in bearing. Any variation of strength due to the joint is undoubtedly less than ordinary assumptions that enter into the theory of concrete design, and hence is amply taken care of by the high factor of safety which is ordinarily recommended.

Although the floor-beams have been previously referred to as T-beams and figured as such, they were not poured at the same time as the floor slab. The detail indicated in Fig. 5 was designed to insure sufficient bond between the top of the beam and the under side of the floor-slab by roughing its surface and allowing the stirrups to project into the slab about two inches.

The slight haunches on the slab itself, fitting into the recess on the sides of the beam, have a possible additional factor for bond, due to the pressure on the sides of the recess resulting from the negative moment in the floor slab.

The design for the various portions of the above structure was made on the basis of a 2000-lb. concrete. The greater portion of concrete structure on the isthmus has heretofore been built from an ungraded mixture of run-of-bank gravel from the bed of the Chagres River. Tests of concrete from this material instituted a short time after the beginning of construction indicated a rather low strength of the resulting concrete.

A washing plant, wherein the gravel descended by gravity down a screen of $\frac{1}{8}$-in. mesh sloping at 45 degrees was installed, and the concrete from this material showed a marked increase in strength, 2700 lb. per square inch being obtained in some cases at the end of twenty-eight days.

Pier construction on the Canal Zone is now being done under the supervision of the building division, Hartley Rowe, then resident engineer, and T. C. Morris, assistant engineer. The above design was completed by F. W. Blackwood, assistant engineer, G. W. True, junior engineer, and E. S. Randolph. C. A. Nelson was superintendent of construction.

Gasoline Tax for Road Funds

Three states, Colorado, Oregon and New Mexico, now have laws for raising road funds by a tax on gasoline. The theory underlying the laws is that road use and road wear are proportional to gasoline consumed. The prevailing systems of basing passenger-car and truck taxes on weight, horsepower or value are recognized as inequitable, since of two vehicles paying the same tax one might run only 2000 miles a year and the other 15,000.

In Colorado the tax is 1c. a gallon; in New Mexico, 2c. a gallon; in Oregon, 1c. a gallon on gasoline and $\frac{1}{2}$c. on distillate. No difficulty has been found in collecting the taxes in Colorado and Oregon, and no objection has been raised to the laws. The New Mexico law, however, has been attacked on the basis of constitutionality, and the case is now before the Supreme Court of the United States. In the two former states the tax is collected from the wholesaler. The laws in these states have been in force about a year and are producing in each state a revenue running between $30,000 and $40,000 per month.

Treatment of Gas Waste to Prevent Water Pollution

Tar and Oil Separators, Aërators and Chemical Treatment in Some Cases, Coke Contact and Fine Gravel-Sand Beds

By E. J. Tully
Chemist, State Board of Health, Madison, Wis.

Illuminating gas liquors present an increasingly urgent problem in the disposal of industrial wastes Because of their complicated and concentrated character gas wastes are liable to cause gross water pollution. This may be prevented by adequate treatment to reduce the organic matter as much as may be necessary to permit final disposal by dilution.

Planning a system of treatment to meet conditions involves combining effectiveness with simplicity of construction, reasonableness in cost and simplicity in operation, elimination of technical supervision, if possible, and recovery of waste products, such as tar, which may be used in connection with road work.

Water gas—or, more properly speaking, carburetted water gas—is made by decomposing steam in contact with incandescent coal or coke and enriching the gaseous compounds with oil, or rather oil gas, the by-products being tar and light hydrocarbons. Coal gas is produced by the dry distillation of bituminous coal, giving coke, tar and ammonia as byproducts. In the case of water-gas manufacture, the gases passing from the generator, carburetor and superheater are discharged into the "seal" and thence to the preliminary scrubbers and the relief holder, from which they are pumped back through the works. During this process the gases are washed, cooled, purified and measured.

In passing through the "washer-cooler" the gas is subjected to a spray of water, and it is at this stage that most of the tar is removed from the gas, this tar constituting part of the industrial waste. The purifying boxes, which receive the gas from the washer-cooler, are filled with a mixture of wood shavings and iron oxide. The function of this material is to remove hydrogen sulphide, the hydrogen of the gas uniting with the oxygen of the iron oxide to form water, the water being drained off at the base of the boxes and going to form a part of the waste.

The volume of industrial waste proper resulting daily from the process of water-gas manufacture varies more or less directly with the capacity of the plant, and is also influenced by certain local conditions, the approximate relation as to capacity being 2500 gal. of waste per 100,000 cu.ft. of gas produced. Because of the peculiar and comparatively concentrated character of the liquor, being turbid and containing considerable floating oily compounds saturated with hydrocarbons and having an appreciable amount of tar, the waste requires, subsequent to removal of oils and tar, prechemical treatment in many instances, in order to obtain the best results. Simple chemical treatment, using either lime or ferrous sulphate and lime, is successful in coagulating and removing by sedimentation a large percentage of the suspended and dissolved matters in the waste, and such treatment makes possible subsequent rapid filtration.

General outlines of plans which have been developed for treating gas-plant wastes are shown herewith. They include a sedimentation unit, which functions as a gravity oil separator, for the retention of tar and light oils; aëration of the effluent from the tar tank by discharge in a thin film over several steps, when sufficient difference in elevation is available to allow of this procedure; chemical treatment, using a few pounds of lime per 1000 gal. of waste, or copper and lime if necessary, in case of coal-gas waste; sedimentation and double filtration through (1) coke contact beds and (2) gravel-sand filters. Differential outlets may be used to withdraw the light oils from the retention chamber, and the tar may be removed by utilizing the hydraulic head in the tank, where sufficient difference of elevation is available to permit the use of this method.

These methods of treatment will give satisfactory results if intelligent care is given to the system, including the removal of oils and tar when necessary, the re-

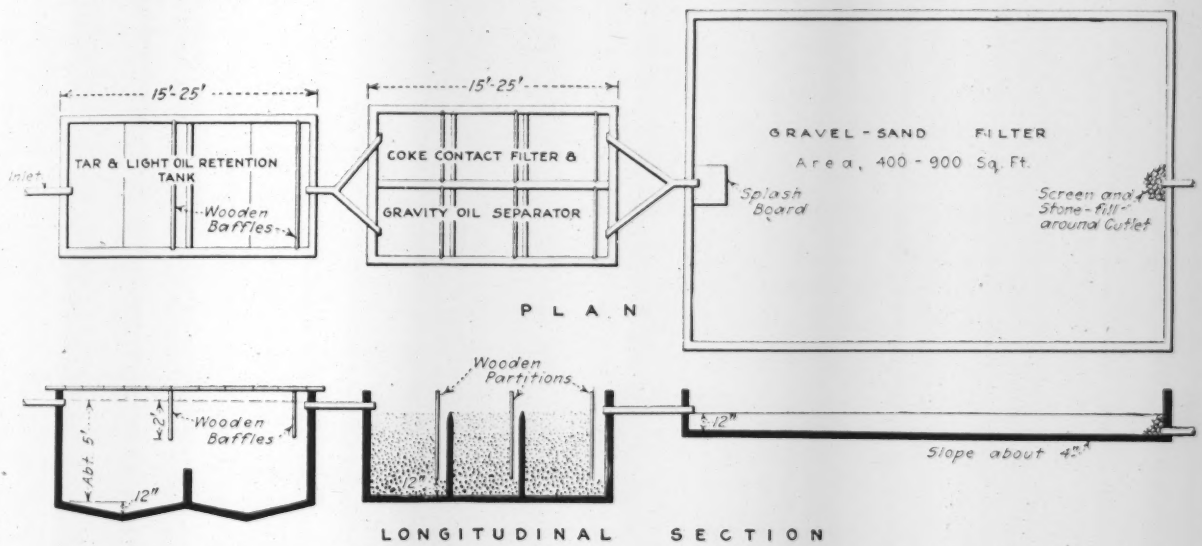


FIG. 1. PLANT FOR TREATING GAS WASTES WHERE LARGE DILUTION IS AVAILABLE
Coke filters: Bottom 1½ feet, 1 inch; middle 1½ feet, ½ to ¾ inch; top 2 feet, coke breeze. Gravel sand filter: Bottom of 1-inch stone; middle 3 inches, of ½- to ¾-inch stone; top, about 8 inches of gravel sand mixture. Filters covered with plank in winter

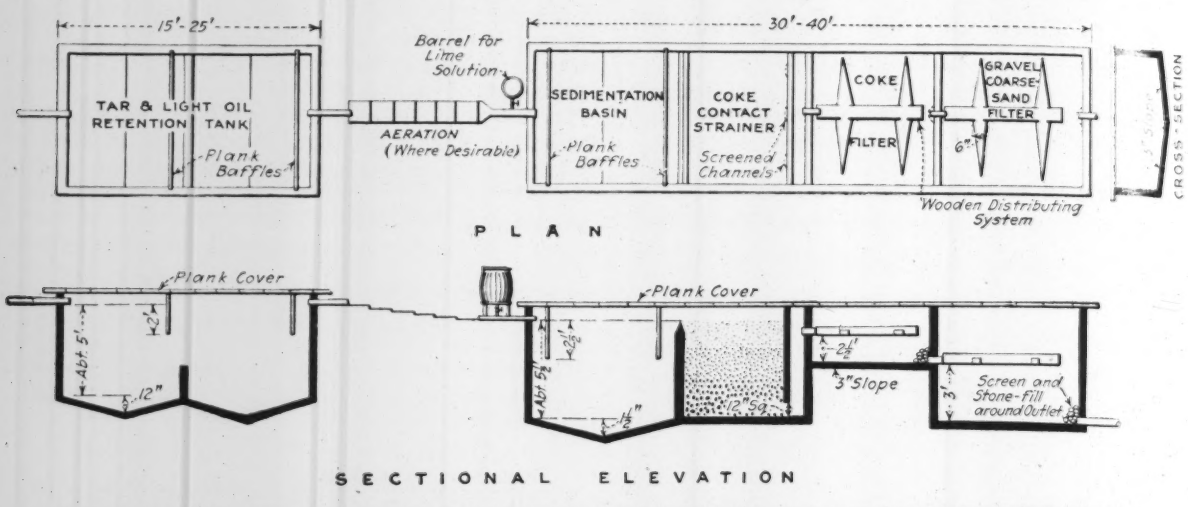


FIG. 2. GAS-WASTES TREATMENT PLANT FOR SMALL DILUTION OR PROTECTION OF WATER-SUPPLY

Coke contact strainer: Bottom 2 feet, 1 inch; top 3 feet, ½ to ¾ inch. Coke filter: Bottom 6 inches, 1 inch; middle 6 inches, ¾ to 1 inch; top 1½ feet of coke breeze. Gravel sand filter: Bottom 6 inches, 1-inch stone; middle 6 inches, ½- to 1-inch stone; top 2 feet, gravel-sand mixture. Where topography does not permit gravity coke filter, contact bed, like strainer may be used.

moval of precipitate every month or so, occasional renewal of coke in the contact filters, and frequent surface raking of the gravel-sand filter.

Fig. 1 shows a system which may be used successfully where available dilution is large. This type, without the tar-retention chamber, is used at the Madison gas plant to treat about 25,000 gal. of waste, and is giving excellent results, producing an effluent as clear as spring water, practically without odor and with but a slight taste.

Where the available dilution is small and either livestock or a domestic water-supply is to be considered, complete treatment, including chemical application, is indicated. Fig. 2 illustrates a system designed to meet such requirements. Modifications of these general plans may be employed to accomplish such results as may be indicated for any particular case.

Zone Law Proposed for Philadelphia

A PROPOSED ordinance which is receiving wide publicity in the press and which is furnishing a great deal of discussion in Philadelphia council meetings is one providing for the regulation of the height, uses and areas of buildings in Philadelphia.

The proposed zoning ordinance, as drafted by the Philadelphia Zoning Commission, provides for five height claasses, based upon the width of the street, those clasases being 1, 1½, 2, 2½, and 3 times the street width. In addition to this, in each district the buildings may not exceed a maximum height, varying from 40 ft. in the "one-times" district to 150 ft. in the three-times-the-street-width district. Above such heights building must recede from the building line at a certain proportion which is 1 ft. for every 1 ft. of elevation in the one-time district, and 1 ft. for every 3 ft. excess height in the three-times district.

There are four districts, classified according to the class of buildings, which may be erected—residential, commercial, industrial, and unrestricted. The unrestricted district will contain such industries as are obnoxious because of excessive emission of noise, odor or smoke. Public garages are not permitted in the residential districts, and the capacity of private garages is limited in proportion to the size of the lot.

There are five classes of area districts provided, known as A-, B-, C-, D-, and E-class districts. In the A-class district, buildings may not cover over 30% of the lots; in the B class, 50% of the lot; in the C class, 70%; in the D class, 80%; and in the E class, 90% of the lot. There are various other provisions, such as that the A-class districts provide for detached buildings, B-class districts for semi-detached buildings, while in the C-class districts buildings may be built in rows. This in general applies to houses.

The members of the commission that drafted this ordinance are: George E. Datesman, director, Department of Public Works; William H. Wilson, director, Department of Public Safety; Dr. Wilmer Krusen, director, Department of Public Health and Charities; E. T. Stotesbury, president, Fairmont Park Commission; Chester E. Albright, president, Board of Surveys; Joseph E. Widener, member of Art Jury; George S. Webster, member of Permanent Committee on Comprehensive Plans; LeRoy A. Worrell, Philadelphia Real Estate Board; John H. McClatchy, Philadelphia Operative Builders Association; Edgar V. Seeler, Philadelphia Chapter, American Institute of Architects; John Ihlder, Philadelphia Housing Commission, and Edgar S. McKaig, Chamber of Commerce. William C. Stanton is the engineer and George R. MacKenzie is his assistant.

Pipe Breaks in St. Louis

Four breaks in four years on a 30-in. main of class A cast-iron pipe laid in 1887 led the officials of the St. Louis water department to investigate the records to see whether the light pipe was accountable for the large amount of trouble experienced, since all of the breaks have occurred without apparent reason. The records indicate that 16 of 19 breaks in large mains, 30 to 48 in., in diameter, have occurred in the class A pipe. Pressures varied from 51 to 89 lb. One class C pipe broke under a heavy viaduct fill.

River and Harbor Estimates For Next Year

Chief of Engineers Specifies Extent and Location of Contemplated Improvements

MUCH of the current report of Major General W. M. Black, the recently retired chief of engineers, U. S. A., has to do with the river and harbor work which is carried on under the direction of his office. Specific reference is made to the various large projects under way.

In regard to the improvement of East River at New York, for which $3,200,000 is asked for continuing the work during the fiscal year ending June 30, 1921, General Black points out that the benefits derived from the improvement cannot be shown by its influence on freight rates or directly by the increase in tonnage, but that the commerce of the river is so enormous that every improvement which facilitates and lessens the dangers to navigation in this waterway is justified. The most obvious effect of the engineering work in East River is given as the increase in the number of vessels of large tonnage using the waterway. The improvement also has made navigation through Hell Gate safer for vessels up to 22 ft. draft. The improvement has as its object the opening of the channel with a mean depth of 40 ft. The program also includes the early removal of Shell Reef to a depth of 25 ft. in order to permit the better development of the Manhattan water front below Blackwell's Island.

Delaware River Requires Two Millions

For the next fiscal year $2,215,000 is asked for the continuance of the work on the Delaware River, from Philadelphia to the sea. The work thus far done on this river has greatly facilitated the movement of deep-draft vessels, says General Black. For the first time during the past year, ships drawing 34 ft. of water have navigated the channel without defficulty. He says that "the improvement of the river has enabled coastwise vessels to relieve greatly the congestion of railway traffic," and that "the economic value of the improvement to commerce has been very great." The new work to be prosecuted during the coming fiscal year proposes the continuation of dredging in Philadelphia Harbor and in the channel, as well as the removal of Mameluke Rock.

Improvement of the Chesapeake and Delaware Canal will require $2,000,000 during the next fiscal year, says General Black. This is a new project. The canal heretofore has been operated under private ownership. The $2,000,000 asked for is to be expended for dredging, purchase of land for right-of-way, and for contract work on the high-land elevation.

General Black asked for $1,200,000 to continue the work on Norfolk harbor. The work already done, he states, has resulted in the use of deeper draft vessels and a diminution in lighterage expenses, and navigation has been rendered easier, safer and better. The combined rail and water routes centering at Norfolk have resulted in lower freight rates between Southern and Eastern points. The next step to be taken in the work is to dredge an anchorage of about 64 acres to a depth of about 35 ft. at mean low water. The 40 ft. channel is to be widened further.

The continuation of the work in the harbor at Charleston, S. C., should have an appropriation of $1,400,000, the report sets forth. The work which has been done has influenced marine insurance rates and has greatly facilitated vessel movements. The port now has deeper water than any other port on the Atlantic or Gulf, south of Norfolk. Vessels drawing 32 ft. of water can now enter the harbor and dock on Cooper River. The expenditure during the next fiscal year is required, for the most part, for a continuation of dredging operations.

Mississippi River Work to Continue

An appropriation of $2,191,000 is asked for the passes of the Mississippi River. The depth of Southwest Pass has now been carried to 30.5 ft. over the bars at the head of that pass. Freight rates have been reduced and greater cargoes carried both for domestic and foreign commerce. The depth of South Pass has been increased to 33 ft., thereby "giving New Orleans high rank as a seaport."

The sum of $2,228,000 should be appropriated, General Black says, for continuing the work on the ship channel connecting Houston, Texas, with tidewater at Galveston. Work already done on this project has resulted in water rates being applied to Houston on a parity with Galveston although 50 miles further inland. Regular steamship service has been established between Houston and Philadelphia. Six oil ships visit the Houston refinery each month. The objective is a 30 ft. channel Most of the sum asked is for continuing dredging.

Funds asked for the continuation of the improvement of the Mississippi River between St. Paul and Minneapolis call for an estimate of $2,750,000. In July, 1917, navigation became possible for the first time over that portion of the Mississippi. Completion of the project will extend the head of navigation to the Washington Avenue bridge at Minneapolis to a low-water depth of 6 ft. This will make possible direct shipment of flour and grain from Minneapolis to the Gulf of Mexico by water.

An appropriation of $2,115,000 is asked for the work planned on the Missouri River from Kansas City to the mouth, during the next fiscal year. According to the report, the work already done on this portion of the river has made possible a regular service and has made available freight rates 20 per cent lower than rail rates.

Continuation of the improvement of the Tennessee River below Riverton will require $1,226,000 during the next fiscal year. The work already done has increased the depth so as to lengthen the navigable season for 6-ft.-draft boats by 3 months.

The sum of $5,000,000 is asked for continuing the work on the Ohio River below Pittsburgh during the next fiscal year. General Black points out that the benefit of this improvement will be felt only when the slack-water system has been extended far enough downstream to permit of continuous navigation over the section of the river connecting the large cities on the upper with those on the middle and lower sections. "The commercial effect of the series of completed dams on the upper river," says the report, "is reflected in the marked increase in general traffic and in the amount of coal shipped from the mines along the Monongahela

to industrial plants on the Ohio at Aliquippa and Midland, Penn., and Steubenville, Ohio." Coke in considerable quantities is being shipped from the Monongahela to steel plants at New Cumberland, W. Va. Coal is also being carried in important quantities.

The Mississippi River Commission asks that it be allowed to expend the full $10,000,000 authorized for flood control work during the next fiscal year. The leveeing of the lower Mississippi has now reached a point where the danger of floods has been reduced to a minimum in all except the most extreme cases of high water. The levee system, however, has not been brought to the standard indicated by the engineer corps as necessary to provide reasonable assurance against any probable stage of the river.

Civil Engineering and Public Health

By Robert J. Harding
General Manager of the San Antonio Water Supply Company, San Antonio, Tex.

Q. What is a civil engineer?

A. Generally, he is that which a college of civil engineering turns out.

Q. Has he ever had any particular function in the engineering world not enjoyed by other engineering professions?

A. Yes; surveying, bridges and structures and sanitation.

Q. But are not the courses in mathematics and mechanics required for the mechanical, electrical and civil engineer identical?

A. They are the same.

Q. Would it not therefore be possible for a graduate of the mechanical or electrical engineering course to enter the field of surveying and design of structures with little handicap as compared with the civil engineer graduate?

A. He could, and it is constantly done; in fact, the civil engineer often gets into the zone of activities of the mechanical and electrical engineer and melts into the work gracefully.

Q. Has the civil engineer any monopoly of the science of hydraulics?

A. This is shared by the other engineering courses, and we find in the field of hydraulic engineering—in fact, in power work—the civil, mechanical and electrical engineer working the same problems with equal ease.

Q. But in this apparent blending of the various engineering courses and professions, is there anything in common concerning sanitation?

A. There is not. Sanitary engineering is not covered by any of the other engineering professions, and belongs strictly to the profession of civil engineering.

Q. Then civil and sanitary engineers are really the same, and the sanitary features of the civil-engineering course are the only distinguishing features which are left to the civil engineer?

A. It may be said that courses in sanitary engineering determine, in truth, whether a man is a civil engineer.

Q. But sanitary engineering is an elective course, and is it then true that many young graduates from civil engineering colleges are really not civil engineers?

A. No, indeed! They are yet civil engineers.

These questions and answers are set up for the purpose of showing that there exists a great similarity in the courses prescribed by the various colleges of engineering. It is so marked that the engineering courses in most of the universities are in one general engineering division, and under one engineering head.

At a recent discussion at one of our large universities of a plan to place the engineering colleges under one head and in one division, it was conclusively brought out that there would be a considerable saving in the cost of instruction and administration, and therefore it was in accord with the economies as developed by the war. There can be no question of the soundness of the decision from the basis of reasoning, but may it not be possible that the great college of civil engineering of this institution is about to lose a good bet?

The question is: Is civil engineering what the college sets it out to be? Yes and no—and no, when there opens up a great opportunity of service in prescribing for the comfort of the people.

Public-comfort engineering, or sanitary engineering, or civil engineering, or social engineering, or what it may be called, is a field in itself. It is large enough to justify a college of its own; and independent enough so there could be absolute certainty of no overlapping and still leeway for plenty of vision. Such a college could be the great clearing house for the things that affect the pleasure and comfort of man, and extend right straight into the realm of public health. It goes so squarely from engineering to public health by way of the civil-engineering route that there seems very little necessity for any college of civil engineering combining with any college. It is an opportunity for humanity to be served through the development of civil engineering's distinctive sanitary field.

The civil engineer belongs in the center of the field of public-health work and should have a knowledge of engineering as at present conceived—all that goes to the sanitary engineer, and then some more. How much more, it is difficult to determine; however, enough to make the engineer perfectly at home in planning broad policies pertaining to the comfort of the people.

Activated-Sludge Plants in Texas

Besides the two large activated-sludge plants at Houston, smaller plants have been put in by Coleman, Gainesville, San Angelo, San Marcos and Quanah, Tex. The San Marcos plant (see *Engineering News*, Feb. 18, 1917, p. 249) has no attendance except for a daily visit. The San Angelo plant, which was put in operation early in 1919, is operated during the day only. The night flow is stored in an old septic tank and siphoned out and mixed with the day flow. Another old septic tank was converted into an activated-sludge tank by the building of troughs in the bottom and the putting of perforated pipes in each trough. The air pipes are ¾ in. in diameter and have two rows of 1/16-in. holes, staggered, the holes being perforated on radii 30° from the vertical each side of the top of the pipe. The air is supplied at 5-lb. pressure by means of a blower driven by an oil engine. No special means of sludge disposal has been provided. The plant has a capacity of 400,000 gal. a day, and is now treating 250,000 gal., according to information supplied by H. H. Elrod, of the Elrod Engineering Co., Dallas, engineers for the plant.

Determination of Kutter's Roughness in a Drainage Ditch

Field and Office Work Described and Conclusions Drawn—Results Indicate Too Low a Value Formerly Used

BY RALPH BOSARD
With Morgan Engineering Company, Memphis, Tenn.

DETERMINATION of the value of n in Kutter's formula recently made on Ditch No. 40 in Grassy Lake and Tyronza Drainage District No. 9, Mississippi County, Arkansas, shows that n should be taken at 0.035 instead of 0.030, as has been commonly done for similar conditions in this section.

This district is situated in northeastern Arkansas and lies in the flat alluvial plain of the lower Mississippi River. Ditch 40 is one of the principal outlet ditches for the drainage system. Above the point where the measurements were made it drains 40 square miles. The soil through which this section of the ditch passes is a stiff, heavy gumbo, very rich and fertile, and the plant growth is quite dense and profuse. All of the perimeter of the ditch above the low-water level is covered with a heavy growth of vines and weeds extending into the ditch a foot or so. The ditch is free of all tree growth, as this is removed every year. At the time of the experiment there were no drifts obstructing the flow, except one large collection of débris at a point about 1200 ft. below the meter section.

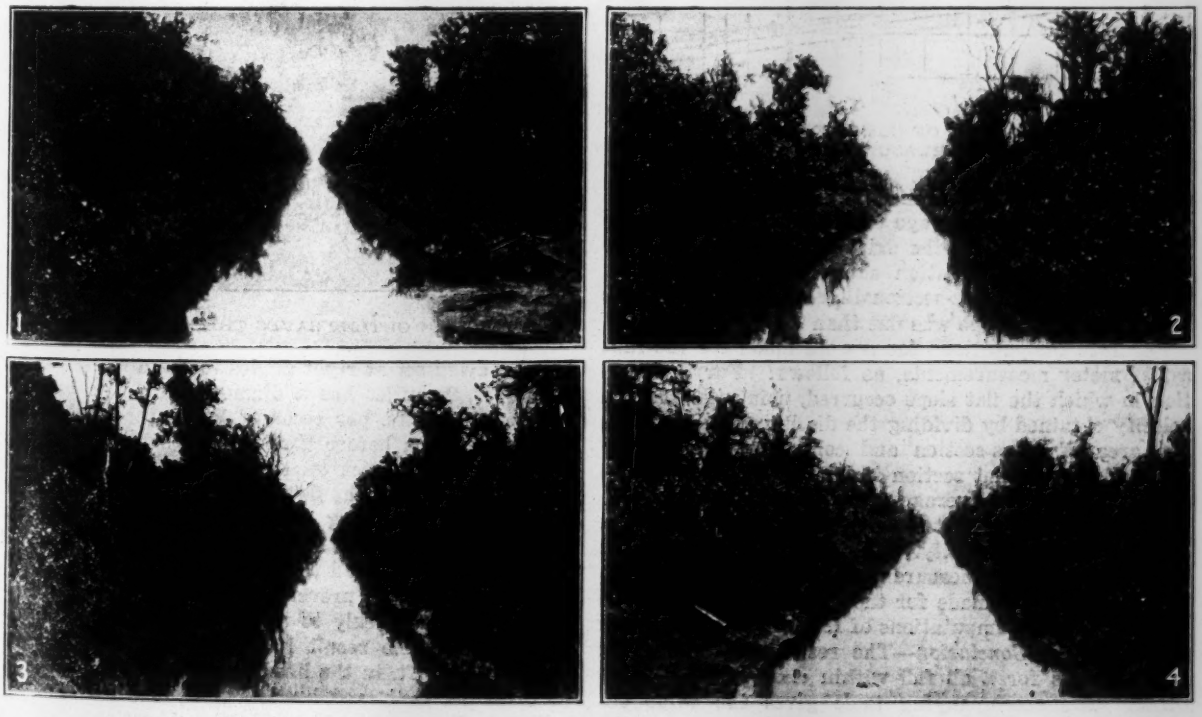
At this point a railway crosses the ditch on a pile trestle, the pile bents being driven at an angle of about 40° with the center line of the ditch.

The accompanying views show the conditions under which the measurements were made. Fig. 1 is a view of the ditch looking upstream from the meter section. Fig. 2 was taken looking downstream from the meter section and shows the railway trestle mentioned above. Fig. 3 was taken looking upstream from the trestle and shows the bridge from which the meter was suspended. Fig. 4 shows the ditch downstream from the trestle.

Field Work—The field work consisted of measuring the discharge of the ditch and the slope of the water surface, and taking cross-sections enough to determine the average area of cross-section.

In measuring the discharge, a Price meter was used. The ditch was divided into 10 vertical sections of equal width, and readings were taken by the two-point method. Duplicate readings were taken at each point. Three complete sets of measurements were made: two of them were taken on a falling stage of the ditch, the third being on a rising stage.

Measurement of the slope of the water surface involved extremely accurate work, considering the instruments used and the conditions under which the work was done. This may readily be realized, as the average fall of the surface was about ¼ ft. per mile. A section of ditch 5000 ft. long was laid off, the truss span highway bridge shown in Fig. 3 being at the center. The meter station was at the bridge. At 500-ft. intervals, benchmarks were set, and enough levels were run over them to determine the difference in elevation between each bench to the nearest 0.01 ft. An 18-in. wye-level and an engineer's transit were the instruments used on the level work. A number of the level readings were taken to thousandths. From the benchmarks, self-reading gages numbered from 1 to 15 consecutively, and graduated in the same manner as a Philadelphia level rod, were set. To measure the slope through the railway trestle, two extra gages above and two below the trestle were set. These were spaced about 50 ft. apart. In taking the gage observations, one complete round



FIGS. 1 TO 4. VIEWS SHOWING CONDITIONS UNDER WHICH KUTTERS' n WERE DETERMINED FOR DITCHES

trip from the upper to the lower gage and back to the upper was made; readings were taken constantly during the operation of the meter, and another complete round trip over the gages was made after the meter was stopped. Each individual observation included the gage height, and the time of observation. This program for taking the gage readings was repeated in full for each set of meter measurements, all three of which were taken on different days.

Cross-sections were taken at each gage point. Above the water surface, the points were selected at the break of the slopes. Below the surface, the points were taken at 2-ft. intervals horizontally.

Office Work—After the elevation of the benchmarks and the zeros of the gages were adjusted each gage reading was reduced to elevation. The observations were platted, elevation against time, for each set of meter measurements, and lines averaging the points for each gage were drawn. These lines were practically parallel in all cases, showing the difference in elevation of the water surface at each gage to be very nearly constant. A vertical, along the line representing the time at the middle of the meter operation, was then drawn, intersecting the line of each gage. An instantaneous profile of the water surface was then drawn, the elevations being taken from this plat. A separate hydrograph (Fig. 5) was drawn for each set of gage readings. It was found the slope of the surface was not uniform. Between the upper three or four gages, the

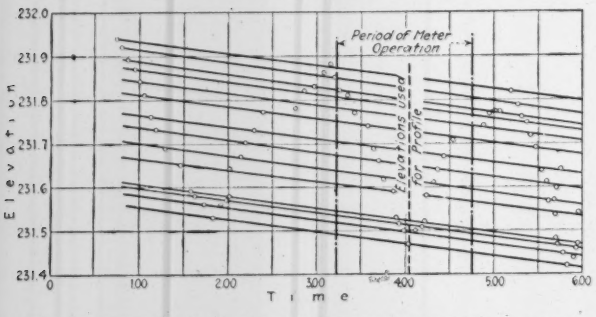


FIG. 5. HYDROGRAPH OF GAGES FOR FIRST SET OF DITCH MEASUREMENTS

slope was much flatter then between the next four, while below the eighth gage the continuity of the slope was broken because of the drift piled against the railroad trestle. Investigation showed, as would be expected, that the cross-sectional area was quite a bit larger where the slope was flat than where it was steep.

Separate computations for n were made for the first set of meter measurements, as follows: For that section in which the flat slope occurred, using the average velocity obtained by dividing the discharge by the average area of cross-section and computing an average value of R; for that section in which the steeper slope occurred, using the average velocity; and for the entire section between the first eight gages, using the average slope radius and velocity. This was repeated for the other sets of meter measurements, except that only two computations were made for the second set. This made eight individual computations of Kutter's formula for n.

Results and Conclusion—The results of the various computations for n all fall within close range of each other. The accompanying table gives the value obtained in each computation. The average of the eight values is 0.0377. Four of the results are within about

TABLE SHOWING VALUES OF n FOR EACH COMPUTATION

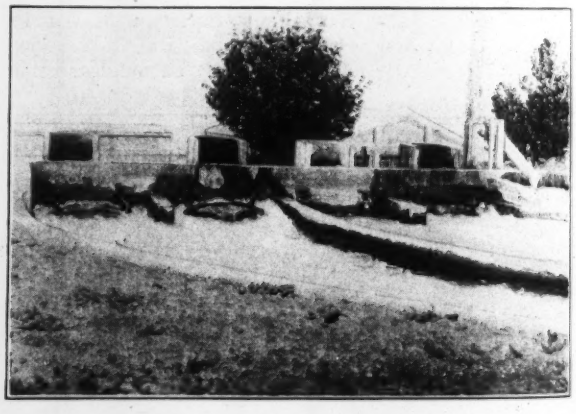
Result No.	Gaging No.	Between Gages	Slope Ft. per 1000	Value of n
1	1	1–5	0.000045	0.0356
2	1	5–8	0.000072	0.0374
3	1	1–8	0.0000583	0.0374
4	2	4–8	0.00007	0.0346
5	2	1–8	0.0000552	0.0374
6	3	1–5	0.0000505	0.0356
7	3	5–8	0.000092	0.0382
8	3	1–8	0.0000666	0.0376

5% of the average, and the remaining four are within 1 per cent.

The values found are about in line with those given by the various authorities for channel conditions met in this set of experiments. It is not uncommon in the rich alluvial soil of the Mississippi delta to find ditch channels with the character of growth found on Ditch 40. From the results of this set of experiments, it would seem that for ditches in soil of this kind the value of 0.030, which is the one most commonly used, is not high enough. Instead, the value of 0.035 is probably the one more nearly correct.

Training Partition in Canal Inlet Increases Capacity

A SIX-INCH concrete partition in the discharge chamber at the head of pressure pipes from No. 2, one of the three main pumping stations of the Minidoka project of the United States Reclamation Service, has been used to good advantage in straightening out the threads of current, thereby reducing the velocity head lost. As noted in the photograph, each of the four outlets is supplied with a flap valve secured



PARTITION IN OUTLET SAVES THREE PER CENT HEAD

to a headwall set at right angles to the direction of the canal. Each outlet has a diameter of 5½ ft. and discharges 160 cu.ft. per second. When the pumps were run to capacity, before the training baffle was put in, water from the inlet on the inner side of the angle seriously disturbed the flow of the water on the outside of the curve, causing violent eddies and back currents. The partition simply divides the chamber in half from the headwall to the beginning of the tangent of the canal and prevents interference whereby a stream tends suddenly to transform velocity head into static head. The result has been a reduction of approximately 1 ft. in the head pumped against, a saving of three per cent.

The baffle was placed under the direction of Barry Dibble, manager of the Minidoka project.

Reduced Lime Feed Saves Money and Lessens Deposits

Grand Rapids Plant Now Lets Hardness Rise to Lake Michigan Softness, Reducing Help, Wash Water and Chemicals

SO FAR as evidence is available, the reduced lime feed process, which was put into operation last autumn at the Grand Rapids water-purification plant, in an effort to lessen troublesome deposit difficulties, has been successful. Walter Sperry, chief chemist, in the annual report (not printed) for the fiscal year which ended Mar. 31, 1919, indicates that there has been little complaint of the 25% increase in hardness over the former full treatment, the rate of deposition in stills and apparatus around the laboratory is materially smaller, and the savings in chemicals, wash water, labor and power have been large. At the annual overhauling in the winter the filter underdrain sand and gravel were found in better shape than ever before. There is not yet much evidence convincing to the layman, for many ⅝-in. service pipes are being removed due to cumulative clogging, the major deposition occurring in past years.

Lowered unit costs in the face of increased prices for materials and labor have been obtained, and Mr. Sperry hopes the alternative of returning to a full softening and a reduction of the normal carbonate akalinity by an additional dose of alum, much as is done at Columbus, Ohio, will not be necessary because of the added expense following the reductions the present treatment effects. Comparative data from the report follow:

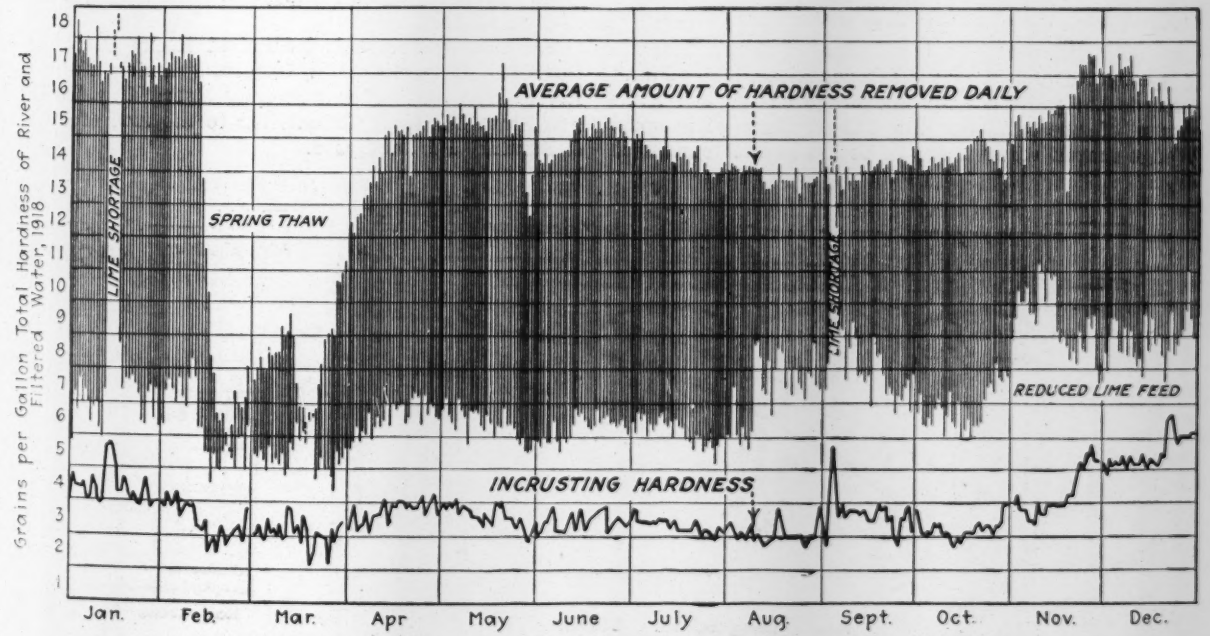
The total costs per 1,000,000 gal. for operation and maintenance of the plant for the year 1918-19 were $16.88—10.4% less than for the preceding year. Costs for chemicals still showed the effects of the war, lime being increased from $9.05 to $11.43 and alum from $24.52 to $32.03 per ton. Power costs were increased 27.3% from April to December and by an additional 54.5% (to 2c. per kilowatt-hour) for the remainder of the year. Notwithstanding these increases in unit prices, and also an increase in pumpage, the decrease in the amount of lime used after Aug. 10, 1918, resulted in a saving of $10,000 to $12,000, or about 3%. During the late autumn, winter and early spring months one filter attendant and one chemical feed man have been dispensed with. Wash-water percentages, beginning with 1915-16, have been as follows: 1.9, 2.1, 1.98 and 1.15% for last year. Corresponding quantities of water treated were 10,370,000, 11,760,000, 11,480,000 and 12,480,000 gal daily.

COSTS PER 1,000,000 GALLONS TREATED

Year	Wages	Chemicals	Power	House Water	Supplies and Repairs	Total
1915-16	$4.48	$5.10	$2.17	....	$1.11	$12.86
1916-17	4.26	7.37	2.26	....	.98	14.87
1917-18	4.86	10.06	2.23	$0.20	1.49	18.84
1918-19	4.32	8.16	3.29	.25	.86	16.88

The average prices for lime for the four years were $5.81, $6.40, $9.05 and $11.43 per ton, with the following quantities in tons used per month: 201, 272, 262 and 213. Similar data on alum indicate the tonnage used during the past year was about the same as four years ago: 20.2, 34.2, 40.8 and 19.7 tons being used, costing $19.98, $21.92, $24.52 and $32.03 per ton, respectively. Lime is now purchased on a penalty-bonus basis whereby 1% of the purchase price f.o.b. quarries at Bedford, Ind., is allowed for variation above or below 87% CaO content, the base price being $8 from June to December and $9 from January to March. The lime averaged 86.5% CaO.

Typhoid cases and deaths per 100,000 population in Grand Rapids for the period 1907 to 1912, before the



HARDNESS CONDITIONS AT GRAND RAPIDS WATER-PURIFICATION PLANT

The upper ends of the vertical lines show the daily hardness of the water for the year, which averaged 13.5 grains per gallon. The length of the vertical lines indicates the amount of hardness removed daily, which averaged 7.3 grains per gallon or 6.65 tons of lime rock per day from 12,760,000 gal. of water. The curve formed by the lower ends of the vertical lines shows the daily total hardness of the filtered water. The component parts of this residual hardness are indicated by the curve of incrustant hardness, the spaces between this curve and the black area indicating carbonate hardness, and that below sulphate hardness.

filters were installed, averaged 202 and 27. For the six-year period since then cases were 99 and deaths 15. A chart for the calendar year 1918, submitted by Mr. Sperry, indicates 33 cases of the disease and five deaths.

Bacteria per cubic centimeter in the river during the calendar year 1918 averaged 1524, with a maximum day of 35,000 and a minimum day of 125. Corresponding counts of the filtered water (on agar at 20°C) were 7, 200 and 0. B. coli were found 3.3% of the time in 1-c.c. samples, 23.5% in 10-c.c. and 28.5% in 50-c.c. samples.

Turbidity ranged from 5 to 285, averaging 16 p.p.m. in the river water. In the settled water it ranged from 2 to 84, with an average of 12. No turbidity got through the filters.

Previous to Aug. 10 there was nearly always caustic alkalinity left, varying from one to nine parts, but the filtered water contained only about 50 parts of alkalinity.

After Aug. 10 the caustic alkalinity was kept to zero, the total hardness going always above 100 parts, whereas it had been held previously considerably below 100 parts. Averages for the calendar year 1918 are as follows: Total hardness, river, 231, and filtered, 107; alkalinity, river, 191, and filtered, 60 parts. The chart reproduced herewith indicates the chemical conditions for each day of the year.

Arch Bridge With Ribs Anchored by Concrete Keys

Design for Concrete Viaduct at Rocky Point, Oregon, Has 113-Foot Arch Span—Steel Rib Rods Embedded at Abutments

By C. B. McCullough
Bridge Engineer, Oregon State Highway Commission, Salem, Ore.

A UNIQUE detail in the design of the reinforced-concrete viaduct over the Rogue River, Rocky Point, Ore., is the provision for anchorage at the end abutments of the ribs for the 113-ft. clear arch span. Wedge-shaped recesses are to be cut in the foundation rock, and the main rib bars embedded in concrete poured therein.

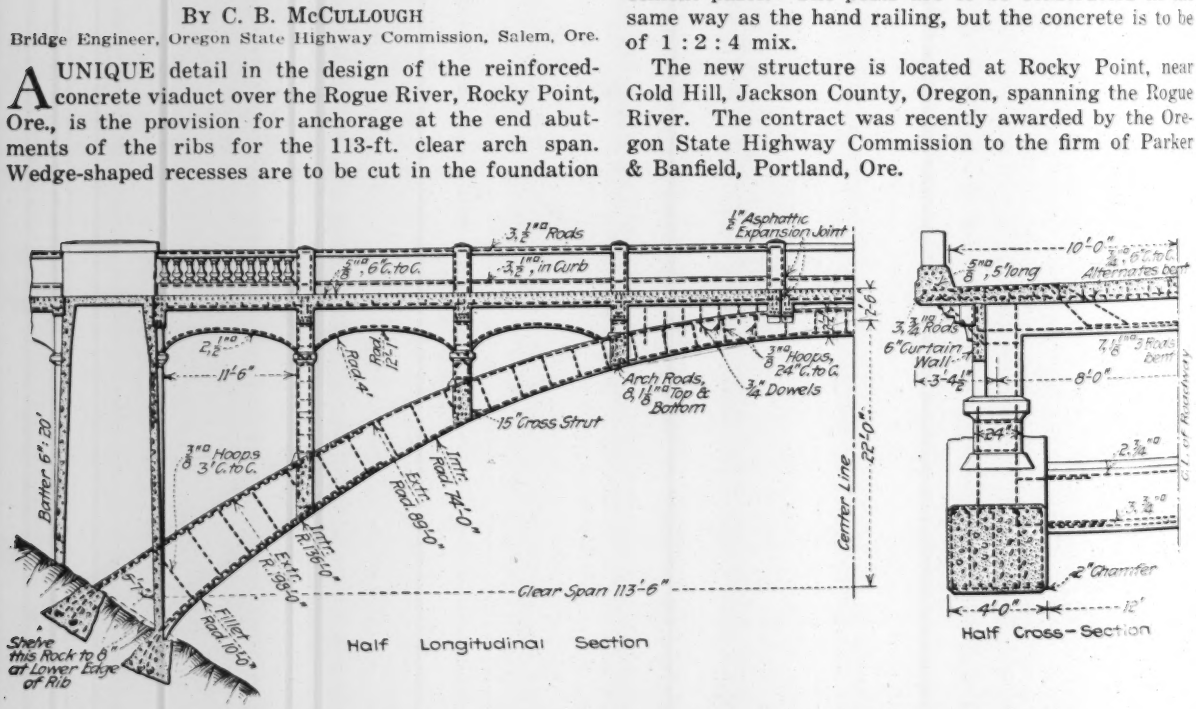
The new structure, 552 ft. long, will consist of a central open spandrel arch with clear span 113½ ft., flanked by 17 deck girder approach spans, each 23½ ft. long. The clear roadway width is 20 ft. The floor loading is to be carried by a longitudinal floor slab to transverse girders and thence to the vertical spandrel posts. The structure is designed for a live loading consisting of two 20-ton motor trucks plus a uniform live loading over the unoccupied portion of the deck of 80 lb. per square foot.

Sprung from solid rock cliffs, the main arch will span a rather deep rocky gorge. Two parabolic arch ribs 4 ft. wide, 26 in. deep at the crown and 79 in. deep at the springing line, will support the spandrel posts. Transverse struts are to be placed at each panel point, of width 15 in. and depth equal to that of the arch rib.

Anchorage for the rib bars is to be provided at the foundations by means of key openings cut in the solid rock, into which the anchor bars are securely concreted, provision being made for an embedment of 50 diameters. The concrete used for these rod anchor pits is to be 1:2½:3 mix., placed comparatively dry in layers of about 8 in., and well tamped before the next layer is placed. The rib rods are to be hooked under ¾-in. anchor rods, as shown in the drawing. Concrete is to set two weeks before any form work of the ribs or piers is started. No explosives are to be used in the rock work, the walls to be made jagged.

All concrete, except in railings, balusters, etc., is to be 1:2:4 mixtures. Exposed surfaces are to be finished with carborundum brick, and all corners are ¾-in. bevel. The balusters are precast 1:2½ mix., finished with carborundum before being placed, also with a brush coat of cement paste. The posts are to be constructed in the same way as the hand railing, but the concrete is to be of 1 : 2 : 4 mix.

The new structure is located at Rocky Point, near Gold Hill, Jackson County, Oregon, spanning the Rogue River. The contract was recently awarded by the Oregon State Highway Commission to the firm of Parker & Banfield, Portland, Ore.


Clear Span 113'-6"
Center Line
Half Longitudinal Section
Half Cross-Section
Clear Roadway
Curtain Wall
Alternates
Chamfer
Hoops
Dowels
Cross Strut
Rods
Hoops, 24" C. to C.
Arch Rods, Top & Bottom
Expansion Joint
Rods, in Curb
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Engineering and Construction Prospects in Roumania

Much Work Needed on Railroads—Several Large Bridges To Be Rebuilt—Paved Streets Needed—Harbor Extensions Desirable

By Robert S. Doman
Of the American Red Cross

AMERICAN engineers, railroad men and oil experts would do well to investigate business prospects in Roumania. Bridges must be built, railways constructed or double-tracked, canals excavated, harbors extended and the oil wells reopened.

A few months ago Roumania had only 84 locomotives. She has since obtained others, but needs hundreds more. The present inefficiency of the Roumanian State railways is due to the lack of locomotives, passenger and freight cars and to insufficient trackage. The most important state lines are single-tracked and long before the war the Government considered installing a double-track between the principal cities. Traffic today on Roumanian roads is so heavy that passengers ride on the roofs of every train by the hundreds. The Government also is considering the electrification of the Bucarest-Predeal railway line, one of the most important in the country. The electrical power will have to be supplied from waterfalls near-by.

Roumania is traversed from the Carpathians to the Danube by innumerable streams which would greatly relieve the traffic problem if they were canalized. The project of a canal from Bucarest to the Danube is again receiving attention. The possibility of making the Sereth and Alt Rivers navigable also is being considered. The improvement of navigation on the river Pruth was contemplated before the war by a commission of delegates from Austria-Hungary, Roumania and Russia. The advisability of deepening the bed of the river was brought forward but the idea was abandoned on account of strong objections on the part of the Russian delegates.

Americans also have the opportunity of doing for Roumania what the French are doing at the headwaters of the Rhone in the way of developing water power. An idea of old Roumania's potential hydraulic power can be gained from the fact that the flow into the Danube averages 1023 cubic meters per second.

Bridges Must Be Rebuilt

Owing to the general destruction of bridges during the war there is an exceptional opportunity in Roumania for American bridge builders. A bridge over the Danube to connect Roumania with Serbia was being considered by the Roumanian government when war broke out. In addition the great bridge over the Danube at Cernavoda must be reconstructed.

It is now reported that the contract for the reconstruction of this bridge, in many respects the greatest structure in Europe, may go to a French firm. This bridge, known as the King Carol Bridge, is 1260 ft. long and 114 ft. above the water. One branch of the bridge crosses the Danube at Cernavoda and another at Fitesti. It is the only bridge between Novi-Sad in Hungary and the Black Sea.

The viaducts and embankments between Fitesti and Cernavoda are more than 11 miles in length. The bridge across the main stream is intact, but near Fitesti there is a broken section 600 ft. long. The movement of oil, grain, and miscellaneous freight to and from the sea to interior Roumania depends upon this bridge.

In addition to the contemplated bridges across the Danube there are 18 important bridges in other parts of Roumania to be rebuilt. American engineers should hurry, however, for British, French and German contractors are alive to the opportunities awaiting them.

Harbor extensions have been made necessary by Roumania's economical growth and the fact that there will be in the immediate future much more traffic between America and Roumania than before the war. American shipping interests should prepare to make use of the Danube, taking an example from the British, who plan to invade the Danube countries, from the Black Sea to Ratisbon in Bavaria.

Roumanians are much pleased at the announcement that an American shipping line will soon have vessels plying directly between New York and Constanza and Galatz. The present harbor at Constanza, however, is much too small and during rough weather this spring, the captains of a dozen American flour boats from Seattle, who put in there, were held up for days for fear of colliding in the narrow basin with other ships or with the sea walls at the mouth of the tiny harbor.

Capital and Other Cities Need Paving

American street-paving interests also have an excellent opportunity awaiting them in Roumania's larger cities. Most of the larger cities have a few streets paved with asphalt, but this paving has not been repaired in five years and the streets in Bucarest and elsewhere are in horrible condition. The work of asphalting Roumanian cities had only begun when the war broke out and usually there is only one or two of the principal streets in each city which have been favored with a smooth surface. The others are paved with cobblestones.

In Bucarest a new central railroad station will be built within the next three years. The existing one proved totally insufficient during the war. In addition to the building of the station, more trackage, signaling apparatus, etc., must be installed.

Roumania would welcome the investment of American capital in her undeveloped resources, for the coming of the American Red Cross into the country has created among the Roumanian people a great affection for everything American. Twelve shiploads and 19 trainloads of food, medicines and clothing have been distributed by American men and women throughout the country and typhus and smallpox have been stamped out. The gratitude of the nation toward America is sometimes pathetic.

Bussiness men have found much to admire in American ways of doing things and of getting results in a hurry. American office appliances as used by the Red Cross and the one hundred and fifty-odd automobiles and trucks used by the same organization have served to introduce American mechanical products to Roumanians.

American business men should hurry, however, for already the hotels of Bucarest are filled with German and French salesmen. One hears German spoken everywhere. In the fight to capture the Roumanian

market foreign salesmen are making great use of the American flag. For instance, shoes which from their short vamps are too obviously made in western European factories are displayed in Bucharest shop windows, each pair with an American flag peeping forth. "Made in New York," the signs read, although the modeling indicates German handiwork.

American business men are now flocking into Greece and Constantinople where one sees familiar brands of American toothpaste, soap and toilet articles for sale everywhere. But only a few salesmen have as yet reached Roumania, a country which needs everything and will soon have the money to pay for it. It would be well to give six months' or a year's credit in some cases. Roumania differs from Serbia, Montenegro, Albania, Bosnia and Macedonia, however, in that it will make a lightning recovery from the war and will have plenty of money to spend as soon as this year's grain crop and oil output are sold.

The country's greatest needs are for agricultural machinery, hardware of all sorts, window glass, soap, sugar, shoes and leather goods. But an American bringing over anything from pins to locomotives would be sure of sales.

Irrigation in the Fourteenth Census of the United States

Nature and Extent of Works, Capital, Operating and Cost Figures, Water Used, Drainage and Water Rights Covered

By R. P. Teele
Special Agent in Charge of Irrigation, Bureau of the Census, Washington, D. C.

Under the law providing for the Fourteenth Census of the United States, the inquiries relating to agriculture are to include the quantity of land reclaimed by irrigation, the crops produced, the location and character of irrigation enterprises, and the capital invested. The wording of the law and the general plan for the inquiry were suggested by a conference of persons interested in irrigation called together by the Director of the Census in December, 1917.

The preparation of definite plans for carrying out the law and the suggestions of the conference was begun July 1, 1919. A schedule of inquiries has been prepared, and plans for the field work are well under way. In suggesting inquiries the conference kept in mind three things: All inquiries should be contained in a single schedule; data should be collected to present comparisons with the results of preceding censuses; and such new inquiries as seemed particularly desirable should be added.

The conference also adopted certain definitions, some of which are fundamental and, consequently, are given below. The law calls for information regarding "irrigation enterprises," and the following definition of an enterprise was adopted:

"An irrigation enterprise, for the purpose of the census, is a canal or canal system, pumping plant, or reservoir supplying water for irrigation, or any combination of these, operated under a single management by either an individual, a partnership, a company or other organization."

As a guide in determining what land should be classed as irrigated, the classification printed below was adopted.

Land should be classed as irrigated which has water supplied to it for agricultural purposes by artificial means or by seepage from canals, reservoirs or irrigated lands, but land which has natural groundwater sufficiently near the surface to support plant life should not be classed as irrigated. Land which is flooded during high-water periods should be classed as irrigated if water is caused to flow over the land by dams, canals or otherwise, but should not be classed as irrigated if the overflow is due to natural causes alone.

The two leading inquiries, acreage irrigated and crops grown under irrigation, are carried on the general farm schedule, which goes to every farmer in the United States, so that this part of the irrigation census will apply to the whole country. It is not planned at this time to obtain additional data for irrigation in the East, but if the returns from the agricultural canvass in the East disclose the practice of irrigation to a large extent in any section, the question of collecting data as to equipment, etc., will be taken up later.

All inquiries regarding "enterprises," as distinguished from farms, are to be carried on an irrigation schedule. The subjects covered by this special schedule are as follows:

Description of Works.—This inquiry calls for a brief general description of the character of the works, which will help in interpreting the more specific data as to equipment. The items called for specifically are: Diversion dams, number and material; storage dams, number and material; main ditches, capacity, number, and length; laterals, number and length; pipe lines, size, length, and material; reservoirs, number and capacity; flowing wells, number and capacity; pumped wells, number and capacity; pumping plants, kind of power, capacity of power plant, kind of pumps, number and capacity, average lift. All of these items, except dams, were included in the census of 1910, so that comparisons can be made showing the expansion since that date. It is believed that the data regarding wells and pumping plants will be of special value, as indicating the possibilities of this type of development. The Western states contain millions of acres of fine land that must be supplied with water in this way if at all, and these figures will show where a water-supply has been developed by pumping from wells, the quantities developed and the acreage supplied.

Lands.—The points covered by this inquiry are: Number of farms supplied with water; acreage in project; area actually irrigated in 1919; area enterprise is capable of supplying in 1920; lands available for settlement covered by enterprise; prices of unimproved land suitable for agriculture covered by this enterprise; terms of payment and rates of interest; average cost of preparing land for irrigation. Similar data, except as to cost of preparing land for irrigation, were collected in 1910. The census of 1910 was taken toward the close of a period of very active construction of large-scale irrigation works by both the Government and private agencies, and disclosed the fact that there was a very large area of land for which water was available, that was awaiting settlement. Since that time there has been a decided check, or rather almost a cessation, in the undertaking of new enterprises of large size, and a gradual absorption of the unused lands for which water is available. The data to be collected in 1920 should show how far this process has gone, and how much need there is for further construction at this time. The inquiries as to

prices and cost of preparing land for irrigation will help to give prospective settlers on irrigated land an understanding of conditions to be met in the West. The whole inquiry has an important bearing on the question of state and Federal aid in land reclamation and settlement, which is so much discussed just now.

Capital Invested.—This inquiry calls for the capital invested in irrigation works and equipment and in water rights. The conference previously referred to discussed this inquiry more or less, and it was the general opinion that this inquiry should be considered from the public standpoint rather than from the standpoint of the present holders of enterprises, and consequently "capital invested" is defined for this purpose as "cost." It is evident that there would be a considerable difference in the case of enterprises which have been purchased by their present holders at much less than their cost. There are many such enterprises. Cost is divided between cost of works and cost of water rights, and cost of works is defined as including, in addition to the direct cost of the works themselves, the cost of engineering, legal and administrative expenditures, promotion, and lands, buildings, machinery, animals and tools for use in maintenance and operation. This definition corresponds to that used in 1910, and the results will be comparable. Other inquiries will make it possible to classify enterprises into size and age groups, segregating the large modern enterprises which are of particular value as indices of future possibilities. The instructions to enumerators and special agents will cover such points as the value of work done by owners, the value of other property exchanged for works or rights, etc.

Maintenance and Operation.—The only inquiry under this head is the cost of maintenance and operation in 1919. The instructions state that the cost of permanent improvements, even though paid from annual assessments, should not be included here but under capital invested. This item was included in 1910.

Cost of Water to Farmers.—This inquiry covers the cost of water rights, annual charges, and rates for water, with supplemental questions calling for average charges per acre in case charges are made on some other basis, and for information as to whether rates are fixed by public authority, as a railroad commission or county commissioners. It is hoped that these questions, with those regarding lands available for settlement, their prices, and terms, will give a sufficient basis for a tabulation showing lands to be had under existing irrigation enterprises and the conditions under which they can be obtained. This information should be very useful in outlining future land policies for the nation.

Quantity of Water Used in 1919.—This inquiry calls for the quantity of water received and the quantity delivered, with questions as to measurements and the length of the irrigating season. Similar inquiries were included in the 1910 schedule. Where water is measured the results should be valuable, and it is hoped that there will be enough reported to justify the inquiry.

Drainage.—The drainage inquiry on the irrigation schedule relates to irrigated land only—that is, to lands "that have been irrigated, are now irrigated, or are to be irrigated" by the irrigation enterprises reporting. The questions on the schedule call for the area for which drains have been installed and the additional area in need of drainage, the latter being subdivided into land wholly unproductive, land available for pasture only, and land producing partial crop. This inquiry is new, and the results should settle a much-discussed point—the extent to which land under irrigation has been injured by surplus water and the rise of groundwater. Estimates vary from 5 to 25%, and engineers will be glad to have definite figures covering the point. The prevalence of this condition and the necessity for constructing drainage works in addition to irrigation works have an important bearing on land settlement questions.

In addition to the statistical inquiries outlined above, the schedule contains several inquiries which will serve for classifying the data. These cover the following:

Source of Water-Supply.—The sources named on the schedule are: Streams, springs, pumped wells, flowing wells, lakes, stored stormwater, city water, sewage. The schedule calls also for the name of the stream or other source from which water is taken, and the drainage basin in which the land irrigated is located. In some of the previous censuses the acreage irrigated has been reported by drainage basins, and in some it has not; but this is considered a more logical basis for classification than states and counties. The results of the last census were classified by source of water-supply, and comparisons can be made.

Class of Enterprise.—The classes of enterprises used are: Individual and partnership, coöperative, irrigation district, Carey act, commercial, United States Reclamation Service, United States Indian Service, state and city. The schedule defines these classes and contains an instruction calling for a statement of changes in form if such changes have taken place. This is an important inquiry, because it gives a measure of the effectiveness of various laws which have been enacted for the promotion of irrigation development. Since the date of the last census the states have been very active in revising their irrigation-district laws, and these figures will show whether this has been effective.

Water Rights.—The inquiry regarding water rights also is principally for the purpose of classifying other data, although the amounts of rights are called for. The classes of rights used are: Notice filed and posted, riparian rights, rights adjudicated by courts, certificates or licenses from the states, permits from states, appropriation and use. This classification was used in 1910, and thus it will be possible to make comparisons. These data will indicate the effectiveness of state laws regulating acquirement of rights and providing for defining them as to date and extent.

The presentation of the results of the classification by type of enterprise, and by status of water rights, will require a synopsis of the Federal and state laws covering these subjects.

The time of making the enumeration for the coming census is the month of January, 1920, and the canvass of irrigation enterprises will begin at that time. It is not expected, however, that it will be completed during January, but it should be completed in time to permit the tabulation and publication of the general results, at least, in 1920.

This will be the fourth census to collect statistics regarding irrigation, this inquiry beginning in the census of 1890. In addition, a special census of irrigation was taken in 1902. In 1890 and 1900 the work was in charge of Dr. F. H. Newell; in 1902 in charge of C. J. Blanchard, now of the United States Reclamation Service; and in 1910 in charge of the writer.

Wide Bridge Built as Two Bridges Without Interval

Novel Materials Plant Derrick Designed To Meet Local Restrictions—Industrial Railway Distributed Concrete

USING the same equipment twice and two separate set-ups of the same centers, a four-track, six-arch railway bridge has been constructed by the Illinois Central R. R. at Kankakee, Ill., as two bridges, with no space between, in two successive seasons, ice danger to the falsework being completely avoided during the intervening winter. By careful planning, in the design, for construction in separate halves, and in fixing the time and sequence of operations in the field each season's major concreting operations were brought to a finish well in advance of winter, leaving for cold weather only such work as could be accomplished without special difficulty or extra precautions.

The Kankakee bridge has five 90-ft. and one 60-ft. barrel-arch spans, with spandrel walls and a deck of precast slabs. It is 64 ft. wide, face to face of arch rings. Including piers the structure required about 16,000 cu. yd. of concrete. A single-track, three-span steel truss bridge occupied the site and in respect to it the new bridge was so located that its piers did not interfere with the old bridge piers. The location permitted the full length of the new piers and 28 ft. of width of the superstructure to be built without disturbing the old structure or the railway traffic. Then the tracks were shifted to the completed half of the new bridge, the steel bridge was removed, and the remainder of the new bridge was constructed.

Office design of the bridge to accommodate the construction plans included first, of course, provision for a construction joint longitudinally of the entire superstructure. All piers except the one between the north end 60-ft. arch and the adjacent 90-ft. arch were designed to be stable under dead-load thrust from one arch ring when the adjacent arch ring was not in place, but not stable under such conditions for any considerable superimposed load on the arch ring. In construction, therefore, centers could not be removed from any 90-ft. arch until the adjacent arch ring had been completed. Incidentally, it was specified that no center could be removed until the concrete had been in place 42 days.

The design provided for concreting the arch rings in transverse sections and indicated the dimensions of each section; the sequence in which the sections should be concreted, and the form of the construction joint between sections as shown by the sketches of Fig. 1. The arch centers were also fully designed and the contractor was required to build exactly to designs. They were bolted, framed timber structures, and as a full set of centers, half width for six spans, was constructed, the framing operations were rather extensive. A great labor saver in framing was an electric boring machine operated in an improvised guide frame as described in the "Hints for the Contractor" section of this issue.

Construction proceeded from the south end, where the materials handling and the mixing plants were located as indicated by Fig. 2. Stone and sand coming in on a temporary side track were unloaded by derrick

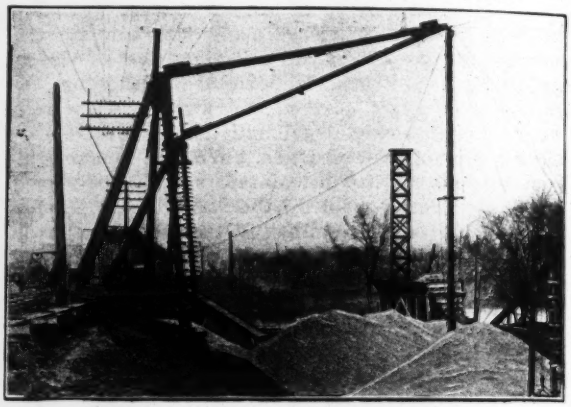


FIG. 2. STIFF-LEG-GUY DERRICK AT MATERIALS PLANT

into stock piles and then by derrick from stock piles into loading bins. From under the bins an industrial track circled around between the old abutment indicated and the rear lines of the new abutment on the water's edge. At bridge floor level a mixer was set with its charging skip guides extending down to industrial track level on the ground. Cars plying back and forth brought proportioned batches from the bins to the charging skip. The cement house, not shown, was located adjacent to the bins for aggregates.

Space for materials was restricted to a narrow strip between the high railway embankment and a parallel street and to complicate matters the property owners across the street refused to allow guy cables to be carried across their property. This necessitated the unusual derrick construction shown by Fig. 2 and explained in principle by Fig. 3, to enable the use of a

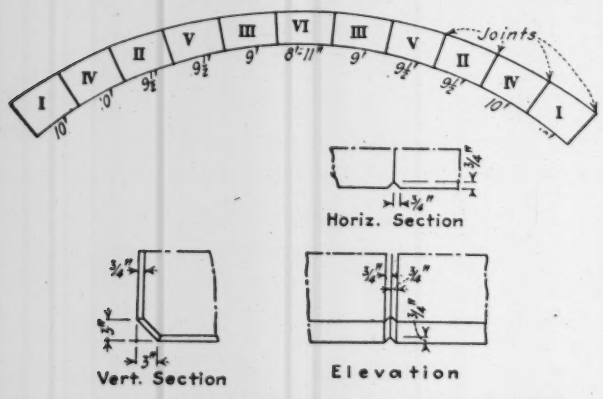


FIG. 1. SEQUENCE IN WHICH ARCH RING SECTIONS WERE CONCRETED AND JOINT DETAILS

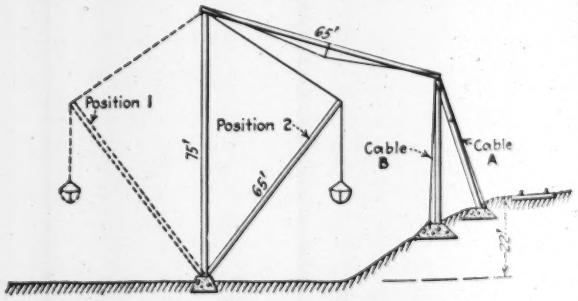


FIG. 3. PRINCIPLE OF OPERATION OF STIFF-LEG-GUY DERRICK

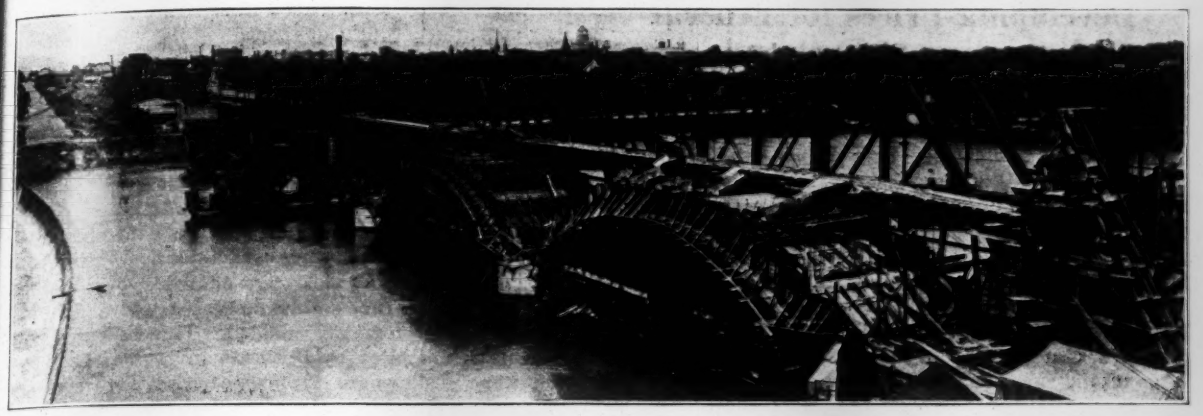


FIG. 4. PLANT ARRANGEMENT FOR CONCRETING FIRST HALF OF BRIDGE

derrick with 75-ft. mast and 65-ft. boom which was required to cover the complete circle of unloading operations.

Two four-post towers, Figs. 2 and 3, were erected on the shoulder of the embankment and 68 ft. from the mast. The posts of these towers were set in heavy concrete footings and their tops were about 60 ft. above the base of the derrick. From the top of each tower to the mast top a 12 x 12 in. x 68 ft. trussed timber was connected. As the towers were approximately 50 ft. apart, the angle between the two guy timbers was about 45°. From the mast head, wire cables A and B were run to a sheave at each tower top and then down the

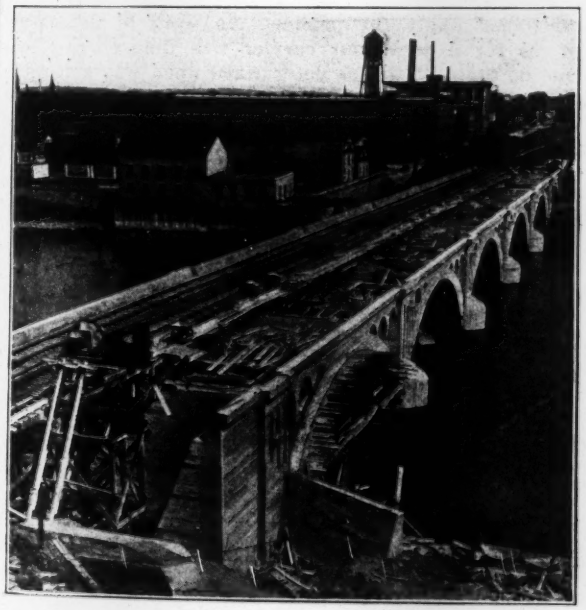


FIG. 5. PLANT ARRANGEMENT FOR CONCRETING SECOND HALF OF BRIDGE

legs as shown to anchorages in the concrete footings. With this arrangement when the boom is in Position 1, cable A comes into tension and prevents the back legs of the tower from kicking up. With the boom in Position 2, cable B holds the front tower legs down in the same manner.

Constructed in the manner described and otherwise guyed as indicated by Fig. 2 the derrick was held stable without guy lines across the tracks or over the property from which they had been forbidden. This derrick operated a clamshell for handling materials.

Distribution of concrete from the mixer was by narrow-gage service railway and side dump industrial cars operated by hand. For concreting the first half as shown by Fig. 4, the service track was supported by the old steel bridge. On the second half of the bridge the track arrangement was as shown by Fig. 5. From one to five 18-cu. ft. cars were employed in delivering concrete. With a ½ cu. yd. mixer a maximum of 240 cu. yd. of concrete in place in 10 hours was attained.

The final operation was placing the deck slabs. A total of 312 slabs were precast at a yard located south of the bridge. The larger slabs were 10 ft. 2¼ in. x 6 ft. 11¾ in. x 1 ft. 6 in. and contained 3.7 cu. yd. of 1:2:4 concrete heavily reinforced. The slabs were cured a minimum of 30 days and placed by a derrick car running on the bridge.

The Kankakee bridge was designed by the engineering department of the Illinois Central R. R., C. C. Westfall, bridge engineer. J. H. Graham was resident engineer in charge of the work for the railroad. The contractors were the Gould Construction Co., and the Walsh Construction Co., Davenport, Iowa, with Alf. Lepard in charge.

Careful Census of Manufactures To Be Taken

According to a bulletin issued from the Bureau of the Census, Department of Commerce, Washington, D. C., a special effort is being put forth to make the manufactures section of the approaching 14th decennial census the most nearly complete and comprehensive inventory of the nation's manufacturing establishments ever taken. Schedules tabulating information concerning the country's industrial resources have already been prepared and printed. These schedules will be mailed to every manufacturing establishment in the United States during December, so that factory owners and managers can familiarize themselves in advance with the questions to be answered when the records of the past year's business have been compiled. In 1914, the year when the last manufactures census was taken, approximately 275,000 manufacturing establishments were listed. This time more than 300,000 establishments will be scheduled, and, in addition, it is expected that about 50,000 mines and quarries will be reported.

Developing Prices for Federal Valuation of Railroads

By Henry J. Saunders
Bureau of Valuation, Interstate Commerce Commission, Pacific District, San Francisco

THE Federal valuation act, passed by Congress in March, 1913, required the Interstate Commerce Commission to report the value of all property owned or used by every common carrier subject to the provisions of the act. As soon as the organization and procedure for determining the inventory of physical units of property were well under way, the question of prices to be used was of most importance. It was determined that prices as of June 30, 1914, and freight rates of the same date, would be used on the valuation. The exact price in force on that date for any article was not considered as a final price to be used unless it was also a fair average of prices for five to ten years previous. In other words, prices were generally to represent a fair average of prices paid for materials and labor during the period covering the years 1910-1914, inclusive.

In order to accumulate data on the cost of various commodities during the period, the commission on Feb. 9, 1915, issued Valuation Order No. 14, in which it was ordered that every common carrier should furnish the commission a schedule showing purchases made and net prices paid for such purchases, this information to be filed with the commission in a manner prescribed and on certain forms which were then designated. These purchases in many instances could represent only a few of the largest made by that carrier during this period.

The returns under this valuation order were filed in Washington, where a cost bureau was organized and the data were tabulated. The returns were also filed in the various offices in the district in which the reporting carrier happened to be located, and were there used as a basis for the determination of fair prices.

In the Pacific district, with headquarters at San Francisco, an organization was perfected, with a cost engineer as its head, which proceeded to tabulate cost data from various sources. Many carriers' offices were visited, and abstracts were made of all grading and other contracts which were available. The carriers' accounting records were examined, and a great deal of data, such as final estimates and cost records of company work, quantities for which were known, was secured. The commission's accounts, in their preparation of the accounting report and original cost to date, also obtained valuable items of detailed cost. This was especially true of such accounts as tunnels, bridges, and tracklaying and surfacing. A thorough analysis was made of all representative jobs which could in any way be used to develop unit cost. Valuation Order No. 14 was used by the cost engineer in determining a great many average unit prices, such as for ties and items of other track material. The cost bureau at Washington from time to time furnished representative prices on such items as rail, spikes, bolts, etc., which prices were adopted as basic unit prices in the district. This bureau also furnished a number of manufacturers' quotations on such items as pipe, cement, etc.

The district cost and pricing force collected and tabulated the data, as noted above. Grading contracts were segregated geographically, and various parts of the country covered were placed in separate zones where it was considered conditions were similar. Data covering cost of such material items as ties were tabulated, and weighted averages obtained. These weighted averages, however, were very seldom used exactly as obtained. They merely served as a guide for a fair price. The cost engineer would determine, from such data as he had tabulated, certain fair prices to be used for certain items in the valuation. These prices when obtained were accompanied by all supporting data obtained on the subject. A conference was then held, attended by the various district and staff officers, where the data and price were thoroughly discussed and a final fixed base price was formally adopted. These adopted prices were then compiled by accounts in regular book form and were used where applicable on all future reports. Whenever additional supporting data are secured, which, in the judgment of the conference, warrant revision in price, a revision is then carried through in the same manner as a new price.

Some idea of the enormous mass of data used may be gained when it is said that on one kind of cross-tie purchases of over 5,000,000 ties were used in obtaining a fair average price. Millions of pounds of spikes, bolts and angle bars were used as representing fair purchase prices of these items. Tracklaying and surfacing cost on 7000 or 8000 miles of track was used in obtaining a fair price for work under this account. Grading contracts for all lines in the Pacific district were obtained wherever they were still in existence. These data in themselves made a huge mass of information.

After the inventory units were finally collected and assembled ready for pricing, the work of developing prices for a particular carrier was then carried out. One of the first things determined upon was a feasible construction program for reproduction. This program was always drawn up in standard form and showed the following information:

1. Name of railroad.
2. Description of country traversed.
3. Statement of mileage by valuation sections.
4. Location of all connections with other carriers.
5. Transportation facilities.
6. Statement of assumed methods to be considered in reproduction of various accounts.
7. Table showing material yards, foreign connections, length of haul from material yard to section, and distance from nearest labor center.
8. Construction and interest periods.

This program was used by the pricing force as a basis for development all prices on the carrier concerned. The assumed material yards and f.o.b. points were considered in determining prices on material, and freight or haul by company train was figured from point of purchase of material to these yards. Base prices for materials were the same for all roads when materials were purchased at the same point. Final prices, however, would vary according to the amount of freight paid. In illustration of the above: It was determined to use a certain price for 7 x 8-8 redwood ties f.o.b. San Francisco. This price would then apply to all roads obtaining material from San Francisco. The price itself as finally used, however, would carry an addition of the necessary freight from San Francisco to the material yard of the carrier or valuation section being priced.

A brief description of the methods used for building up prices in the various accounts prescribed by the commission is as follows:

Account 1; Engineering—This account is determined as a percentage of road accounts Nos. 3 to 48, inclusive. Data for determining this basic percentage were obtained from nearly $400,000,000 worth of work. Engineering, as shown in the accounts of the carriers, consisted of salaries and wages, transportation expenses, subsistence, engineering instruments, tools, etc., and various sundry items. The percentage which these were of the total cost of the road accounts was considered as a fair representation of the probable cost of engineering on reproduction. In determining the final percentage to be used on a particular carrier, due consideration was given to the character of the territory traversed and the remoteness and difficulties of construction.

Account 3; Grading—Supporting data for base prices under this account were obtained almost entirely from actual contracts of work performed in the same vicinity and under similar conditions. To this base price as finally determined was added a definite percentage to cover miscellaneous expense. This miscellaneous expense was intended to take care of the cost of unmeasurable items, such as temporary roads and bridges, changes and repairs to ditches, removing logs from right-of-way, and all such items of unusual expense, usually covered on actual construction by force account or company work. This percentage varied with the conditions encountered. Data for this percentage were obtained from the cost of some $90,000,000 worth of work. To the above base price plus miscellaneous expense was also added a percentage to cover the cost of transportation of men, supplies and outfits. This percentage was determined on the basis of the distance which the valuation section being priced was from the nearest labor center. Data for the determination of this percentage were obtained from some $32,000,000 worth of work.

The main items of grading, such as earth and rock excavation, were priced in this manner: The item of haul of materials was divided into three classes; namely, team overhaul, train haul by contractors' outfit or dinky equipment, and train haul by standard equipment, using the company track, which was assumed as already constructed. The price of team overhaul was determined per cubic yard per 100 ft. in excess of 500 ft. free haul. The maximum distance under this class of haul was usually 2500 ft. These prices, of course, were determined from average contract prices paid in the territory priced. Train haul, using contractors' dinky equipment and contractors' track, included the cost of hauling the material from the point of excavation to the point of unloading, also the cost of unloading, shifting tracks and of temporary trestles where needed. The average haul under this heading usually did not exceed 1.5 miles. Prices were developed from the actual cost of a large number of jobs usually paid for on a flat price basis. The cost of train haul by standard equipment was computed on a basis similar to the above, except that in addition to the cost of haul the estimated cost of a temporary trestle was added.

Account 5; Tunnels—Supporting data for labor and material prices in this account were obtained from contractors' final estimates and original contracts and costs for this class of work. Owing to the different tunnel sections encountered, it was deemed necessary to price tunnel excavation on a cubic-yard basis. To the assumed base price for tunnel excavation was added a percentage to cover miscellaneous costs, which would necessarily be incurred in connection with the excavation. This included temporary wagon roads, which in some instances in particularly inaccessible country was a considerable item. This percentage necessarily varied with the character of the country and distance from other railroads. An additional percentage was added to this excavation price to cover transportation of men, supplies and outfits, this percentage being based on the total distance from some representative labor center.

The price used for material for lining tunnels included:

1. Base cost at point of purchase.
2. Commercial freight from point of purchase to point of delivery on carriers' lines.
3. Haul over carriers' line to material yard (if any).
4. Material-yard expense.
5. Team haul from material yard or end of track to tunnel site.
6. Miscellaneous expense to cover various incidentals.

Under 2, above, it is well to note that the regular tariff rate in effect June 30, 1914, was used to determine freight charges on material Under 3, above, a representative figure was obtained covering an average of carriers' costs for handling construction material. This figure was applied on a ton-mile basis. Under 4, material-yard expense was developed from a large amount of data showing the costs of handling various materials in material yards. Under 5, a price was obtained from various contracts which represented the average cost of team haul per ton-mile. This cost was adopted for all team-haul work. In this connection it was sometimes found feasible to consider that concrete linings were placed in a tunnel after the company track reached the structure. In these instances the cost of estimated team haul was omitted, but additional haul over carriers' line was allowed. The price of labor placing tunnel linings, both timber and concrete, was determined from an average of a number of contracts for this class of work. To this base price of labor was added a percentage to cover miscellaneous expense, and a percentage to cover transportation of men, supplies and outfits.

Account 6; Bridges and Culverts—Basic cost of materials used under this account was determined, as outlined in a previous paragraph, from various purchases of the carriers in this district. These purchases were tabulated and thoroughly analyzed, and a fair average price was adopted in all cases. This price necessarily was at point of manufacture or point of origin. To this base price of material was added the following:

1. Through commercial freight from point of origin to point of delivery on carrier's line.
2. Material-yard expense, varying with the kind of material used.
3. Haul by carriers' train from point of delivery on carriers' line to point of use.
4. In some instances a team haul for such items as culvert material and small bridges built ahead of tracklaying.
5. Labor, varying with the kind of structure constructed.
6. A percentage to cover cost of transportation of men, supplies and outfits from the nearest labor market to the valuation section in question.

7. A percentage to cover miscellaneous expense or in some cases, as in piles and timbers, to cover loss and waste.

The above additions to the base price were supported by data obtained from actual construction costs or from contracts. It was found in a great many instances that carriers' contracts for labor on similar work varied to so great an extent that it showed there was undoubtedly some other consideration not stated which governed the price paid. Contracts of this form receive only minor consideration. Enormous masses of data covering bridge contracts in the Northwest were used in connection with this account, and it is probable that the average prices used represent fairly the cost of this class of work.

Account 8; Ties—9, Rails—10, Other Track Material—Basic prices for the material under these accounts were obtained from data covering carriers' representative purchases, as noted in a previous paragraph. To these basic prices were added:

1. Commercial freight from point of origin to point of delivery on carriers' line.
2. A material-yard expense.
3. Haul over carriers' line from point of delivery to material yard.
4. Cost of inspection based on average prices paid by carrier for inspection of the kind of material being priced.

In a great many instances, base prices were furnished by the Washington cost bureau and were formally adopted by the engineering board for use in all districts. This covered such items as rail and the principal track fastenings. The material-yard expense allowance was determined from carriers' own costs. The cost of inspection was determined in like manner.

Account 11; Ballast—Base prices for the various kinds of ballast were determined from carriers' actual costs. In some instances very good data were developed and costs were found fairly uniform. The cost of a great many million yards was used in developing a fair price for various kinds of ballast. In determining a base price for a particular carrier the following subdivisions of the cost were considered:

1. Pit-development expense.
2. Work-train service at pit.
3. Rental of pit equipment.
4. Labor and steam-shovel expense.
5. Unloading expense.

To the assumed base price was added the cost of train haul which, when over the carriers' lines, was estimated on a yard-mile basis from data similar to that used in determining the price of train-haul material used in Account 3. An addition was also made on a percentage basis to cover the cost of transportation of men, supplies and outfits, from the nearest labor market to the center of the valuation section being priced. When ballast was purchased off from the carriers' line, the full commercial freight at tariff rates was added to the base cost.

Account 12; Tracklaying and Surfacing—This was one of the most difficult accounts to price fairly on a reproduction basis. It was determined to develop the basic cost per mile, which would include the following elements:

1. Labor laying track.
2. Train service.
3. Rental and repair of equipment.
4. Running surface (ballasted track only).
5. Full surfacing (unballasted track only).
6. Additional percentages to cover miscellaneous expense, use of tools, and liability insurance.

The basic price was developed in such a form that it could be applied to the cost of tracklaying for rail weighing under 61 lb., 61 to 90 lb., and over 90 lb. In addition to the above basic cost, an amount was added:

1. To cover the cost of curving rail when curves were 5° or over. This cost was added on a lineal-foot basis.
2. An addition was made for full surfacing on ballasted track where under the assumed construction program it was necessary to reach a ballast pit before the line in question could be ballasted.
3. An allowance based on the cost of hauling material where the distance to the center of the valuation section in question was more than the average distance from the assumed material yards.
4. An allowance based on the cost per mile per month to cover maintenance during construction. Under the construction program mentioned in a previous paragraph a period of construction was assumed which included the time that the track was in operation during construction. This average time for the valuation section was used as an assumed maintenance period.
5. A percentage allowance to cover the cost of transportation of men, supplies and outfits from the nearest labor center.

In addition to the prices developed for tracklaying and surfacing, prices were also built up for the following:

1. Placing ballast under ties, per cubic yard.
2. Placing such small items as tie-plates, rail braces, anti-creepers, etc.
3. Placing switches, derails, crossings, etc.
4. The framing and placing of bridge ties.

Account 18; Right-of-Way Fences—Owing to the fact that there are apparently an endless number of types of fences, it was early decided in the Pacific district to price fences as far as possible by the different items of material entering into their construction. Therefore, a price was developed to cover the cost of posts, wire, nails and staples, lumber, gates, etc. To this basic cost were added:

1. Commercial freight from point of origin to point of delivery on carriers' lines.
2. The necessary haul over the carriers' line on a ton-mile basis.
3. Material-yard handling varying with each kind of material used.

Labor prices were developed to cover:

1. The cost of stringing barbed wire per single wire-mile for various spacing of posts.
2. The digging of post holes and setting posts, varying with different kinds of soil.
3. The labor charged for placing lumber.
4. The cost of stringing woven wire per wire-mile for various spacing of posts.
5. The placing of stays.

Additions were made to the above basic labor costs to cover liability insurance and transportation of men, supplies and outfits. These additions were in percentage form applied in a manner illustrated in previous accounts.

Account 15; Crossings and Signs—Various signs and other material and labor entering into this account were essentially similar to the items priced in previous accounts, and the unit prices were built up in exactly similar ways.

Accounts 16 to 25, inclusive; "The Building Accounts."—Prices for the material entering into these accounts were built up in a similar manner to the prices used in Account 6; that is, to the base price

developed at the point of origin, from carriers' records of purchases and other sources, were added certain percentages and allowances to cover the various items of miscellaneous expense, transportation, etc. The price of labor in these accounts was usually based on carriers' records of original cost plus certain additions, such as transportation, etc. In many instances it was found in pricing particular structures that the carriers' record of cost represented a fair reproductive value.

From the information collected covering structures of various types, a number of diagrams and tables were developed to be used in pricing structures of similar design. One method of pricing buildings used was the square-foot-area method, and diagrams were developed to use in pricing where the units were square foot of floor, walls, roof, etc. Other diagrams were developed showing weights of buildings and accessories to buildings. Tables were used for pricing such items as doors, windows, lighting, heating, etc. The advantages of the diagrammatic form of estimating buildings were that detailed computations were eliminated except in some extreme cases. The diagrams permitted of easy interpolations or intermediate readings. Errors were more easily detected than when detailed computations were made.

Other Road Accounts—Other road accounts were priced in similar manner to all of the foregoing.

Accounts 51 to 58; Equipment—The carriers' report of the cost of equipment was generally used as a basis for pricing equipment of similar kinds. It was necessary, of course, to make different additions for freight and delivery charges than the carrier showed on its original cost records, but the main basis of pricing equipment of a certain kind was given in the carriers' statements furnished the commission.

Accounts 71 to 75 and 77; General Expenditures—A percentage was added to the sum of amounts shown under Accounts 1 to 48, inclusive, to cover the item of general expenditures.

Account 76; Interest During Construction—As stated in a previous paragraph, the construction program shows the number of months to be allowed for interest during construction. This period is generally considered to be one-half of the total period which the valuation section is assumed to require for complete construction. To this period is added an arbitrary time of three months. Interest on equipment is allowed for a total period of three months.

Tile and Concrete Flat-Slab Floor Being Tested

The United States Bureau of Standards is now conducting a test on a specially built floor structure of the type known as Schuster system, which is a girderless floor in which the slab proper is made up of two-way hollow-tile floor construction. Reinforced-concrete beams, running in both directions, are made by pouring concrete in the openings left between square tile, spaced uniformly across the slabs. The substructure has 6 panels 16 x 16 ft., 6 panels 16 x 19 ft. 3 in., and 6 panels 16 x 22 ft. 6 in. Control cylinders have been poured which will be tested at intervals so as to determine when the concrete attains a strength of 2000 lb. per square inch in compression. As soon as possible after this date the load tests of the slabs and strain-gage readings during loading will be taken.

Compressed Air Used to Clean Road Surface Before Oiling

Road First Swept with Brooms and Then Blown with Compressor—Cost of Cleaning and Application of Binder Given

By Major W. A. Welch
Chief Engineer and General Manager, Palisades Interstate Park

AN INTERESTING experiment has just been made, which may be of interest to highway engineers, in putting a new wearing coat on the main park drive in the Palisades Interstate Park. This roadway extends from Bear Mountain, on the Hudson River, five miles below West Point, back through the center of the Harriman section of the Palisades Park to Tuxedo, a distance of 12 mi. It was built four years ago, opened immediately, and has carried heavy traffic continuously ever since. Pleasure cars run over it at high speed; automobile trucks use it; and steel-tired wagons and trailers have been hauled over it with traction engines, drawing wood and lumber from the forests. Until this season, no repairs were made to the surface since the road was opened. The road is of bituminous macadam, penetration method, and was placed in three layers on a base of hand-laid telford, 15 in. deep. The stone was all granite, both telford and the macadam, and was quarried and crushed along the line of the road. The paving is 16 ft. wide, with 3 ft. stone shoulders on each side.

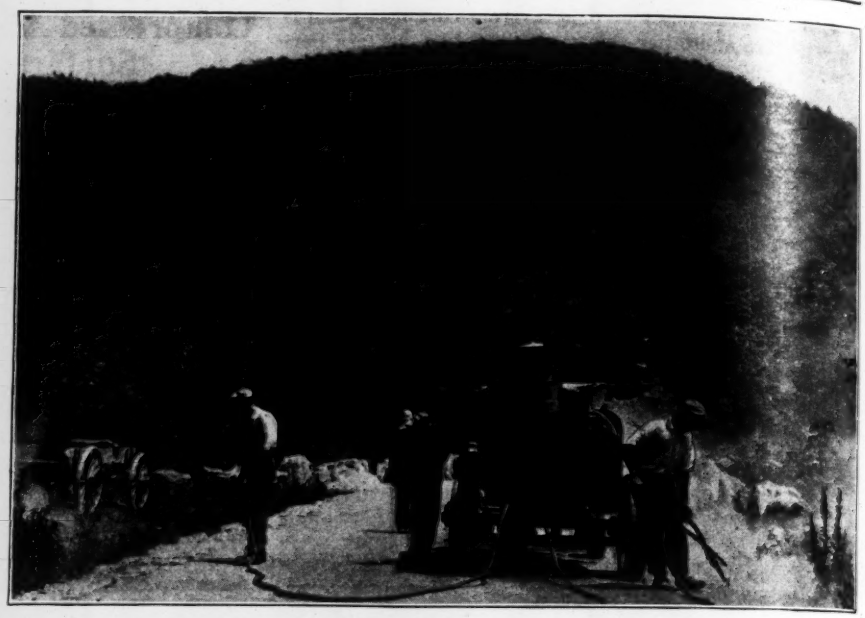
Construction Explained

In the building of the road, after the telford base was completed, a layer of 1½-in. stone was spread and rolled to 2 in. in thickness. On this was poured from hand pots 1 gal. per square yard of Standard Oil binder-B. A second layer of stone of the same size and thickness was then immediately spread and rolled, and a similar application of 1 gal. of binder-B was applied to this second layer. Over this was spread, immediately, a layer of stone 1 in. thick; this was at once rolled in thoroughly. An application of ¾-gal. per square yard of binder-B was then made and was covered with enough screenings to enable the roller to work.

No pockets had been formed and there were no signs of ravelling in the road, but its surface had worn down until the ¾-in. stone showed throughout its entire length. This stone had worn slightly, and the entire surface was much like that of a grindstone.

It was decided to place a wearing coat on the road last spring. In order to insure a proper bond of this coat with the base, the road was first swept with wire brooms. Then a small portable air compressor, of 75-cu. ft. capacity, was equipped with two hose fitted with ¼-in. aperture nozzles; this compressor was hauled over the road behind the sweeping gang and all the dust was blown from the road surface. This compressed-air outfit was operated by three men. It covered about one-half mile of road per day and left the road perfectly clean. A seal coat of binder-B was then applied hot to the road surface by a sprinkling truck, and adhered perfectly. The truck was followed by a crew of men who spread granite screenings to a depth of about ¾ in. on the seal coat. These screenings were rolled in at once by a 10-ton roller. The binder was applied at a temperature of 350°, at the rate of ½ gal. per square yard. The

weather was very hot while the work was being done; the screenings were firmly embedded in the binder, and there was very little bleeding after the road was opened for traffic. Wherever bleeding did appear the screenings were swept back over it, and after the road had been opened for about a week the fast-moving cars had blown most of the remaining screenings to the shoulders. A careful examination shows that there is a practically perfect bond between this seal coat and the original road surface, and the road now has a splendid wearing surface.



COMPRESSED-AIR MACHINE BLOWING DUST FROM ROAD BEFORE BINDER IS APPLIED

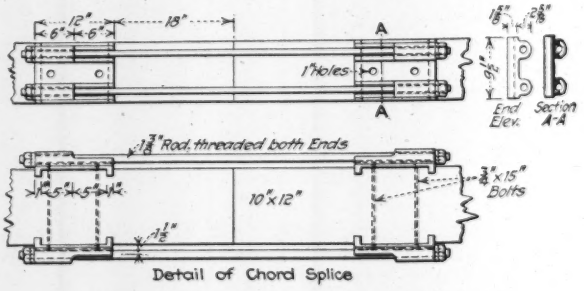
It is difficult, for the following reasons, to give the exact cost of the application of this wearing surface: (1) The distribution of the screenings along the road was done by motor truck. The screenings were dumped at intervals of 50 ft. and the piles were staggered so that the shovelers would have no difficulty in covering the whole surface rapidly. The cost of the distribution of these screenings was much greater in some sections of the road than in others, on account of the length of haul, but the cost of hauling averaged about $1.10 per cubic yard; (2) Eight men with wire brooms swept about one-half mile of road per day. (3) The compressed-air machine with its crews covered about one-half mile per day; (4) the binder-B was heated in tank cars at one end of the road, and the trucks were only able to make two trips per day to points beyond a five-mile haul, three trips per day to points beyond a three-mile haul, and four or five trips on the shorter hauls. Each of these trips covered about 1200 ft. of road. (5) Sixteen men were required to shovel the screenings onto the road, and these men were, of course, only engaged in actually shoveling screenings about two hours of the day on the extreme hauls. They were kept busy in fixing up the parapets and gutters and in forestry work, when not actually engaged in spreading the screenings. (6) The steam roller was likewise idle a great part of the time when the trucks were on the long hauls. (7) It was necessary to open the road to traffic each Saturday and Sunday while this work was being done, and this necessitated the resweeping and blowing of one-half mile each Monday. (8) On three occasions, the delivery of the binder-B by the railway was held up, and this necessitated laying off the entire crew for one or more days at a time. (9) Accidents to the motor trucks used to spread the oil caused three delays of one or more days. (10) Rainy weather, when no work was permitted, also caused three delays.

63 cu. yd. of screenings at $1.10 per cu. yd	$69.30
4700 gal. binder-B at 12.65c. per gal	594.55
2 air compressors with crews, $20 each	40.00
1 steam roller at $20	20.00
16 shovelers at $3	48.00
16 shovelers at $3	48.00
1 foreman at $5	5.00
Total cost per mile	$824.85

The delays attributed to the above causes brought the cost of this job up to $1106 per mile. Had it been possible to put more oil trucks on the job and another compressor, and so cover the road at the rate of one mile per day, the cost would have been as shown in the accompanying table.

A Splice for Wood Trusses Not Affected by Shrinkage

THE extent to which fir timber, usually more or less green, is used for bridge and roof trusses in the Northwest has led to the design of a type of splice that would avoid the danger of loosening due to shrinkage of the wood and the likelihood of decay between scab and timber, these being the chief defects ascribed to wood or metal-plate scab splices. The new splice



SIMPLE CARPENTRY FEATURES SPLICE

was designed by S. Murray, chief engineer of the Oregon-Washington Railroad & Navigation Co., and is shown in the accompanying illustration. It is intended particularly for use with fir timber, which has a notable amount of shrinkage.

In this splice the rods carry all the tension, the castings being subjected to compression only. The simplicity of the carpenter work required is a feature. The rods are threaded far enough to provide for tightening up the bolts later, should that become necessary.

Upkeep Problems at St. Louis Filtration Plant

Data on Sand Growth — Removal of Mud Balls — Loose Strainer Plates — Chemical Action on Equipment—Care of Hydraulic Valves

SUPERINTENDENTS' daily difficulties with the operation of a filter plant together with much light on how equipment of various kinds stands up under service comprise much of the last annual report of August Nolte, superintendent of the St. Louis filter plant to E. E. Wall, water commissioner. The notes below are from this report.

Increase in the coating of sand grains during the past two years was obtained by treating samples from various depths with hydrochloric acid. The table printed below indicates that the large encrusted grains float to the surface and are found within the first 4 to 6 in. of the top:

Thickness of Sample in Inches		Mean Distance in Inches from Top		Per Cent. Loss in Weight Due to Acid Treatment	
1917	1919	1917	1919	1917	1919
1	1	½	½	9.8	14.0
1	1	1½	1½	8.9	12.6
2	2	3	3	6.9	11.5
2	2	5	5	4.6	7.3
3	3	7½	7½	3.1	4.9
3	3	10½	10½	2.3	4.8
3	3	13½	13½	1.93	4.0
3	3	16½	16½	1.57	3.2
3	3	19½	19½	1.41	3.2
3	5	22½	23½	1.13	3.3
3½	...	24¼	...	0.86	...

In May, 1918, it was noted that fish, mostly carp, were making an unusual number of holes in the filters. These holes varied from 1 in. to mere depressions in depth and were as large as one inch by two inches in plan. The fish varied in size from mere minnows to 6 in. in length, the average being about 3 in. long. On account of the turbidity and of the depth of water (about 4½ ft.) over the sand surface while the filter is in operation, the manner in which these holes are made could not be studied, but it is supposed that the depressions are due to the impact of the fish striking the aluminum hydroxide matting on the surface of the sand, either while swimming downward in the direction of the current or while nibbling for food. There is no doubt that the depressions are due to fish because the holes are always found when fish are found, and vice versa. The depressions do not seem to interfere with the efficiency of the filters as the effluent from them has no turbidity. The situation might become more serious if more voracious fish, such as catfish, were present. These, however, have very seldom if ever been found on the filters.

Mud Balls

The rate of wash during the year was maintained at 15 gal. per square foot per minute. The practice of screening one section in each half of each filter unit once a month with a ¼-in. mesh screen was continued throughout the year. This screen is 4 ft. 2 in. by 3 ft. 2 in., just wide enough and deep enough to cover the volume from gutter to gutter and from gravel to top of floating sand. The screen is pulled through the same section each month so that comparative results are obtained.

In May, 1918, the maximum number of small mud balls caught on the screen from any one filter was about 2000, while the minimum number was 50. In August the maximum number was about 400 and the minimum 15. These mud balls vary in size from about ⅛ to ¼ in. in diameter. This reduction in the number of mud balls from May to August is attributed to the following procedure: During June and July the walls of each filter were raked with an ordinary gardener's rake with extension handle attached. Each filter was raked about eight times. The raking was done while the filter was being washed. At one wash, one-half of the unit was raked, at the next wash the other half, etc. In this way no extra labor was required to do the work.

Loose Strainers

A loose strainer plate in a filter can usually be located by a heaped spot in the gravel bed. Adjacent to the mound of gravel will be found a depression giving the exact location of the loose portion of the plate. In September an examination of the gravel surface was made in each filter. To do this a T was made of ¾-in. pipe, the vertical leg being about 15 ft. long, the horizontal legs about 6½ ft. total. This T, inverted, was moved inch by inch across the filter unit parallel to and between each two lateral gutters while the wash water was being applied. As long as the gravel surface was level the vertical leg of the T would stand perpendicular; any unevenness would tilt the vertical leg. This procedure also revealed the presence of large mud balls in several of the filters; these were broken up with a rake.

Loose strainer plates were found in nine filters. In each of these filters one or more end strainer plates were bare for a distance of from 1 to 3 ft. It was found that the nuts on the U-bolts were not drawn up all the way. In several cases the nut was only held by a few threads. This condition allowed the plate to raise each time the wash water was applied, and the force of the water threw the gravel aside. Repairs were made by regrouting the plates, drawing up the nuts and replacing the gravel.

The concrete sulphate dissolving boxes in the chemical room have been resurfaced with cement mortar and coated with asphalt. The copper screens in the dissolving boxes are rapidly deteriorating and are not worth repairing so they are being replaced with boards drilled full of holes; these answer every purpose of the screens and are easily removed. The surface of the bottom of the solution tanks is becoming more and more raveled so that it will probably be advisable to resurface the bottom of all the tanks during the coming year. The sides are still intact.

The agitator shafts in solution tanks 1 and 2 have been renewed during the year. There is still one tank, No. 4, that has the original shaft in it; this, however, will be replaced shortly.

The vertical agitator motors in the chemical room have been taken apart and the parts bathed in gasoline. These motors are subject to much dust and canvas hoods have been made to protect them.

Bronze gate valves, around the aluminum sulphate solution, operated as frequently as they are, will not hold up for any length of time. Any attempt to keep them leak proof would mean constant repairing. As long as their leaking does not interfere with the proper application of the sulphate solution and does not cause any waste of solution, it is better to tolerate a little leak rather than make constant repairs.

The 4-in. lead solution lines through which the aluminum sulphate solution is conveyed to the point of appli-

cation have been cleaned several times. Instead of pulling a 4-in. leather disc through as was formerly done and which meant disconnecting a line about every 60 ft., a double rubber disc is used, shot through with water pressure. This only necessitated disconnecting an entire line, about 800 ft. in length, at two places. The disc will pass around bends of 3-ft. radius and through the 4-in. open gate valves on the line. The water pressure required to shoot the disc has averaged from 20 to 50 lb. per square inch. No bulging whatever has resulted from this pressure. With this disc the work of cleaning is done much more thoroughly than by hand, in about one-third the time, and is really a protection to the pipe since it eliminates disconnecting and thereby preserving the gaskets.

The 1¼-in. brass cocks on the 1¼-in. lead solution line to the effluent of each filter have been reground several times during the year. When these need replacement globe valves should be substituted.

The bronze orifice castings in the orifice boxes of the automatic chemical meters and the conical plugs that regulate the area of the outlet have had to be repaired on account of the corrosive action of the sulphate on these parts. The bronze orifice casting was turned out about ¾ in. and an orifice bushing made that would screw into the casting, so that hereafter the bushing, when deteriorated, may easily be replaced. The plugs were turned down and polished. Since these repairs were made the automatic control properly regulates the amount of solution to be fed in proportion to the amount of water passing through the 8-ft. meters.

Last July the three 4-in. venturi meters at the north end of the plant used for measuring the amount of aluminum sulphate applied to the settled water were taken apart and cleaned. The meters were so badly clogged with scale from the alum solution that the diameter at the head was reduced from 4 in. to 3 in., and at the throat from 1⅝ in. to 1⅜ in. Before cleaning, the meters recorded and indicated about 30% too fast. After cleaning the variation was only 1%. It is now a practice to leave the meters disconnected when not in service because it is found that solution standing quietly in a meter deposits scale much more rapidly than when in motion.

Tile Chlorine Pipe

The 4-in. tile chlorine pipe laid as an experiment to convey the chlorinated water to the drawing conduit chamber had to be abandoned on account of the excessive leakage from it. Some leakage occurred at the litharge joints, but the greatest leakage was through the body of the pipe itself.

Several times during the year all of the liquid chlorine meter machines had to be taken apart and cleaned. These new machines have given considerably more trouble than the older float type meter machines, one of which is still in service. The greatest source of trouble with the new machine has been the sulphuric acid used in the manometer. Several times the acid has been shot into the parts of the machine on account of a defective meter control valve. After a few weeks of service the diaphragms in these valves lose their elasticity and the valve begins to stick. Whenever a meter is taken apart some part of it is sure to be broken. This is absolutely unavoidable. The arrangement of the piping and fittings on the back of the plate is so close as to be almost inaccessible. On several occasions the scales calibrated for the machines were checked and found to be in error. The error was due to the stopping up of ports with chlorinated oil. After cleaning a new scale had to be calibrated.

A new beam and scale balance machine built in the department is now being tested. The results from it have been very gratifying after two months of service. As it stands it is but experimental, but the results obtained justify the building of a larger one.

Valve Packing and Rust

The wooden baffle in the drawing conduit chamber was replaced by a concrete one in the early part of the year. This baffle insures a more adequate mixture of the chlorine solution with the filtered water. All of the packing glands on the 240 hydraulic valves in the pipe gallery have been drawn up all the way and new packing will be needed. The packing in about 50 of the valves was replaced during the year.

The leathers in all of the valves operating the rate controllers were taken out of the cylinders and worked up, the rust cleaned off the cylinder and piston heads and painted with graphite. This work has improved the running of the filters. The rust that accumulates between the leathers on each side of the piston head has slightly scratched the cylinder walls. This rusting would probably not occur if the piston head were made of bronze instead of iron. The piston head will probably need replacing sooner or later, as that part of the iron exposed to the water is so soft that it can be cut with a knife. The metal has about the consistency of shale. It is possible that an electrolytic action is set up between the brass and iron, thereby causing the deterioration of the iron.

Standard Method of Determining the Dust Content of the Atmosphere

The continued use of the Palmer water-spray apparatus for determining the dust content of air is recommended in the 1919 supplementary report of the American Public Health Association committee on standard methods for the examination of air (Prof. C.-E. A. Winslow, chairman, Yale University, New Haven, Conn.). The advantages and disadvantages of this and two other methods to the same end are thus summarized by the committee:

The Palmer water-spray apparatus is fairly convenient and portable and permits the determination of the total weight of dust as well as the number of particles in a given sample. It yields, however, only about 60% of the total dust present in the air.

The Kotzé konimeter is even more convenient and portable than the Palmer water-spray apparatus, but it is not possible by its use to determine the weight of dust as well as the number of particles present. Exact comparative data as to the proportion of dust obtained by these two methods are not at present available.

The Bill electrostatic method yields more accurate results than those obtained by the Palmer apparatus, and could, of course, be used for determining counts as well as weights of dust. On the other hand, the apparatus is not as yet in a form sufficiently convenient for ordinary field work.

With all the facts in mind we recommend that the Palmer water-spray apparatus be retained for the present as the standard method for the determination of the dust content of air. It seems probable that the failure to collect all the dust actually found to be present by the electrostatic method will not seriously affect the relative values obtained in different environments.

Changes in the Value of the Dollar

With Relation to Wages, Salaries and Prices

IN EVERY movement for increases in wages or salaries, the increase in the cost of living is one of the reasons urged for the advance. Is it not a fact, however, that we are deceiving ourselves by referring to the pronounced change in economic conditions through which we are passing as "the high cost of living?" We shall not be able clearly to understand and act on the situation that confronts us until we frankly recognize that it is *a change in the value of the dollar* that has taken place.

But someone may say that the two are identical. Let us see. Tell the average employer that he should increase all wages and salaries to an amount proportionate to the increase in the cost of living, and he will very likely argue that the cost of living is the employee's affair, not his; or he will say you are attempting to establish the principle of a "living wage," or he will even assert that the trouble is not the high cost of living but "the cost of high living."

On the other hand, if it is once clearly understood that an actual change in the value of the dollar has taken place, these arguments, which do mislead many minds, are seen to have nothing to do with the case. Not only can we then deal fairly and understandingly with the matter of wages and salaries, but other prices as well. There are literally thousands of cases where business is being carried on today at a loss because the prices charged for the product or the service have not changed to correspond to the changed value of the dollar. Professional men of all classes, those who live on fees as well as those who receive salaries, have been hit hard by the change in the standard of value and the fact that the public does not yet comprehend this change.

And yet it is easy to comprehend. Everybody knows that dollars are only useful to buy things with, and that the measure of their usefulness is the amount a dollar will purchase. The workman who has $20 in his pay envelope on Saturday night receives in wages only what that $20 will buy. If that $20 will buy only half as much as $20 bought 10 years ago, then his wages have actually been reduced one-half, even though his pay in dollars is the same.

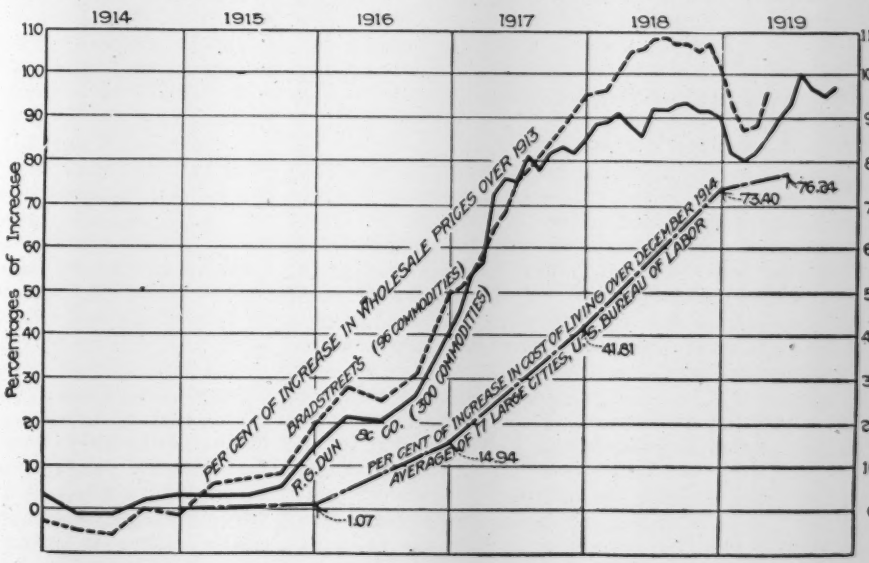
When we talk of increases in wages or salaries, therefore, or of increased prices for goods, we are deceiving ourselves if we measure that increase merely by dollars. The change in value of the dollar must also be considered, before we can determine whether there has actually been an increase or not.

If this is clearly understood it will be apparent how vastly important to every line of business and industry and to every man and woman and child, is the determination of the amount of change that has taken place in the value of the dollar.

Fortunately, there are available statistics which enable the change in the value of the dollar to be determined with reasonable accuracy. The best and most reliable of these statistics are those which have been gathered and published for many years by R. G. Dun & Co. These statistics, commonly termed "index numbers," represent the average change in wholesale prices of standard commodities at market centers. In determining the index number, these average prices are weighted in proportion to the per capita consumption of the different commodities or classes of commodities. Thus the index number, when finally determined accurately, indicates, in comparison with the numbers for previous months and years, the change in the average market prices of commodities and therefore the change in the purchasing power of the dollar.

A number of other organizations also collect and publish statistics from which similar index numbers are determined; but those of the Dun organization are believed to be the most reliable, for the following reasons: First, the Dun organization, dealing directly, as it does, with commercial affairs, is in position to obtain and publish the most authoritative statistics of the market prices of commodities; second, these statistics are from an authority with no bias toward either capital or labor; third, Dun's statistics are based on a much larger number of commodities than those used by other statistical bureaus.

The value of this last feature in eliminating irregularities due to excessive changes in price of certain commodities is obvious and is well illustrated on the accompanying diagram, on which has been plotted the percentage of increase that has occurred in wholesale prices over the average for the year 1913, as shown by the index numbers of R. G. Dun & Co., and also by those of Bradstreet. Bradstreet's statistics are based on 96



commodities as against the 300 commodities used by Dun, and the more erratic course of the Bradstreet curve is evident. On the other hand, it will be seen that the *general* course of the Bradstreet curve does correspond substantially with that of the Dun curve. The general accuracy of the latter is therefore substantiated.

What Index Numbers Show

Let us now understand just what these index numbers, from which the Dun curve is plotted, represent with reference to the value of the dollar. These figures show the percentage of *increase* in wholesale market prices which has taken place since 1913. They, therefore, show the proportional *decrease* in the purchasing power of the dollar in the wholesale market during that time. The average man, however, does not use the dollar that he receives in wages or salary to buy in the wholesale market. He must buy at retail. If retail prices were exactly proportional to wholesale prices, then the index numbers for wholesale prices would indicate also the buying power of the dollar as used by the average man.

Speaking broadly and generally, it is true that retail prices do follow the course of wholesale prices. While there is a considerable difference in the retail prices charged in different communities and for different commodities, it will be generally agreed that the increase in retail prices will very seldom be *less proportionally* than the increase in wholesale prices. It is a well known fact that retail merchants during the five years since the beginning of the war have prospered as never before, due not only to a larger volume of trade but larger margins of profit. As far, therefore, as the Dun index numbers for wholesale prices are in error in representing the increase in the market prices of commodities sold at retail, they are in error by understating rather than overstating that increase.

There is another factor which must be taken into account in determining the change in value of the dollar. The whole of the dollar received for wages or salaries is not spent in buying goods; part of it goes to pay rent. Statisticians have determined that the proportion of family income expended for rent by average wage earners is from 15 to 20%. There are some other minor expenses also which enter into the family budget and which are not included under the head of commodities, such as the service of physicians, payments of carfare, amusements, etc.

Of course, if house rents and prices for professional and personal services advanced as rapidly as the prices of commodities, the index numbers above shown in the Dun curve would still be proportionate to the change in the value of the dollar. It is well known, however, that the increase in rents and in prices for professional and personal service has lagged behind the advance in the prices of commodities. To record truly the changes in the value of the dollar, therefore, proper deductions must be made for the slower rates of advance in these other items of expenditure.

It will be evident that when matters like this are taken up, conditions vary materially in different communities. Rents in cities which had a sudden influx of war workers, for example, advanced in some cases even more rapidly than the advance in prices of commodities. In most cities, however, the increase was very slow, and often no material increase in rents occurred until 1917. Nowhere has the average increase in house rent been as great as the increase in prices of commodities.

The United States Department of Labor in its monthly statistical publication for September prints tables showing the percent of increase in the cost of living from December, 1914, to June, 1919, in 17 important industrial cities in the United States. The items of expenditure of the average family are classified under the heads of (1) food; (2) clothing; (3) housing; (4) fuel and light; (5) furniture and furnishings, and (6) miscellaneous. These various items are weighted in proportion to the relative importance in the family budget, and this weighted total represents the percentage of increase in living costs. The cities for which statistics are given are Portland, Me.; Boston, New York, Philadelpria, Baltimore, Norfolk, Savannah, Jacksonville, Mobile, Houston, San Francisco and Oakland, Portland, Ore.; Seattle, Chicago, Detroit, Cleveland, and Buffalo. The increase from December, 1914, to June, 1919, shown in these tables, varies from 66% in San Francisco to 87% in Norfolk.

For our present purpose, to obtain figures representing the average increase in cost of living and the corresponding decrease in the purchasing power of the dollar as an average for the entire United States, the figures for the 17 cities above named have been combined and averaged. From the averages thus obtained the lower curve in the accompanying diagram has been plotted. This curve represents the best available information at the present time as to the change in the purchasing power of the dollar that has taken place during the past four years, as an average for the whole United States. Comparison of this curve with the curve representing the index numbers published by R. G. Dun & Co., which includes the principal commodities entering into current consumption, makes it evident that the Bureau of Labor Statistics err by understating, if anything, the decrease which has taken place in the value of the dollar.

What the Statistics Prove

Finally, in order to bring the record up to date, these statistics prove that the cost of living is today higher—the purchasing power of the dollar is *lower*—than it has been at any time. The Dun index numbers for the wholesale prices of commodities reached their highest point during the war on Oct. 1, 1918, when the index number was $233.23, an increase of 93% over 1913. Prices fell slightly during the winter and then rose again and on July 1, 1919, the index number reached $233.70, higher than any recorded during the war. Aug. 1 showed a still higher level, $241.65. A very slight fall occurred in September and October followed by another rise and Dec. eclipsed all records, reaching $244.64, an increase of 100% over the average for the year 1914. Even more important in its bearing on the dollar's value is the fact that on Oct. 1 a large increase in rentals took place all over the country.

And now, having obtained reliable figures, from an unprejudiced authority, showing the change in the value of the dollar that has taken place since 1914, it is obvious that they must be applied as a correcting factor to *all* changes in prices, measured in dollars, to determine whether the price, measured by an unvarying standard, has gone up or down. It must be clearly borne in mind that money—the dollar—is only a medium of exchange. If a man sells wheat or

coal or clothing, the true price which he receives depends just as surely on the amount of other commodities the dollar which he receives will buy as it does if he sells his services as a laborer or a carpenter, or a physician or an engineer.

This fact, that the true price of a commodity depends on the average prices of all other commodities, has been generally overlooked in the current discussion on the high cost of living. Before we condemn a trade union for its demands for an increase in wages, a manufacturer for raising the price of his product, or an engineer for asking a higher price for the service he renders, it is fair to ask two questions: (1) Was the price received five years ago a fair one in proportion to other prices then current? (2) How do the changes in price now in question compare with the decrease in value of the dollar that has taken place?

It may be objected that to carry the above-stated principles into effect would tend to raise prices which are now below the standard and thereby to decrease still further the value of the dollar. But this will only be true if such prices are fixed by law and custom instead of by the law of supply and demand and are now below the average level. The question, how to reduce the present enormous cost of living, is another story. There can be little doubt, however, that the prices and wages which should be reduced to bring down the cost of living are those which are now above the average level, not those which are below it. There can be no dissent, either, that the only certain method to bring down prices is to increase production. When the supply of commodities is increased to exceed the demand, then, if the forces of competition be not held in check, prices will begin to fall, and we shall be on the sure road back to industrial peace and prosperity.

Continuing a series of interviews with contractors:

Construction Labor's Instability

An Analysis---

IV.—In which Harry Blenderman, of the Fred T. Ley Co., Inc., partially blames sensational news writing for industrial unrest, and suggests that conditions could be ameliorated by making the union laborer individually and legally responsible for his labor contract.

AT the door of the "unprincipled newspaper," which with sensational scare heads tells its story of strike, murder and riot, Harry Blenderman, assistant to the manager, Fred T. Ley Co., Inc., New York City, lays the responsibility for the fomentation of a great part of the present industrial disorder. Such papers, he says, so lacking in any moral responsibility, have invested the otherwise sane and industrious laborer with a belligerent spirit.

The industrial upheaval, which Mr. Blenderman believes has not yet reached its crisis, antedated the war. Several years before the war he discovered the presence in the ranks of organized labor of an element disposed toward industrial anarchy. The war, with its diverse means of employment, its greatly increased wages and the scarcity of labor gave the radical element the chance to strike a heavy blow. Abetted by the advertising that strikes and riots receive in the daily press, labor has as a result of a war condition gone the limit in its demands—demands founded upon nothing save the laborer's desire to test the limit of his strength.

One strike, properly advertised, is, in the judgment of Mr. Blenderman, strong enough to damage materially all industry. One gang of laborers, seeing another gang making demands, decides that it will do the same. A succession of strikes and riots is inevitable therefore, when newspapers feature all lurid details. So continuously are his elemental emotions played upon that the laborer has been encouraged to assume a fighting attitude. "Once he has tasted blood he cannot be satisfied except with blood."

Through his taste for power coming to him as a result of the labor shortage created by the war; through the activity of a few conscienceless firebrands who have continually preached the exploitation of labor by capital, and through the conscious or unconscious encouragement offered his excessive demands by a sensational press, the laborer has himself become conscienceless, and is fast losing all desire to share either industrial or social responsibility.

The laborer, then, "intoxicated by his prosperity," observes Mr. Blenderman, is actuated by a single motive—to get all he can out of his employer. The sane, industrious building mechanic of former years, possessed of the proper balance of public, private and industrial responsibility, has been relegated to the background. He has been superseded by the younger and irresponsible mechanic. This newer type shrinks at the suggestion of any scheme which will make him share in the lean as well as the fat construction cycles. His attitude takes into account neither the brains behind business organization nor the administrative ability underlying successful management.

Mr. Blenderman emphasizes the fact, expressed in preceding articles, that there is a decided shortage of construction labor. He heartily endorses the plan permitting restricted immigration. The need for foreign labor, he asserts, is urgent. But he offers corrective measures yet unmentioned. The first of these would be to purge the "yellow" press and to eliminate publications designed to propagate disorder and unrest through misstatement and poisonous insinuation. His second corrective suggestion is that the union laborer be made legally, individually responsible so that he will be forced to live up to contracts he signs for the supply of his labor.

Conditions now exist whereby demands made by labor in excess of the contract price must be borne by the contractor. Mr. Blenderman believes it possible to effect legislation whereby the laborer will be held as legally

responsible when he signs his name to a labor contract as the contractor is legally responsible for agreements he enters into. Why such legislation has so far been avoided Mr. Blenderman explains by the fact that politicians generally, realizing from what sources come the greatest number of votes, are not anxious to do anything that will defeat their political desires.

That there is a shortage of labor, which threatens further to complicate matters should the amount of construction materially increase, contractors generally agree to. One thing to be avoided, states Mr. Blenderman, is contractors bidding against one another for different classes of labor. This state of affairs is liable to exist, he declares, in the event that the construction program materially increases, and in the event that the utmost in coöperation is not sought by the contractors.

Should the construction program increase to such an extent that it will force such a condition, Mr. Blenderman suggests a pro-rating of work over a stated period of time or a slight slowing up of all work. A slacking up in, or a cessation of, the construction program is not at all desired, but is accepted as an alternative in the event that contractors get to bidding against each other, thereby causing another sharp inclination upward in the price of construction labor.

One reason why labor is so hard to handle at present, a reason heretofore unmentioned, Mr. Blenderman says, is the fact that during the war building mechanics learned other trades to which they can turn their hands in the event that employers discharge them. The laborer is now so versatile that he has no fear of unemployment if locked out by his employer, or should he strike while working at his chosen trade. Mr. Blenderman also states that though a close combination of the largest contractors might initiate some action whereby the building mechanic could be brought to a partial realization of his dependence upon organized industry, the percentage of small uncontrolled builders would be so large as seriously to militate against any plan conceived to return the laborer to a reasonable basis.

Mr. Blenderman has the advantage of being able to look at the labor situation from both angles—that of the employee and of the employer—because of his former service as a union stone mason and his present responsibilities as a company executive. He has served his time in setting brick in the wall, and is unusually familiar with labor conditions from within the ranks of labor. He earnestly asserts that he has no quarrel with labor. On the contrary, he has its interest at heart though his patience is worn by the increasingly unreasonable demands that a certain radical element enforces the majority to make. Viewing the situation, then, from the double viewpoint of the employer and former employee, he asserts that in many instances labor is demanding even more than it itself expects to gain.

Agreeing that corrective measures are to be found in welfare work, increase in the use of construction machinery, and restrictive immigration legislation, Mr. Blenderman adds his suggestions: Purge the newspapers; control construction, if necessary even to cessation of building; let contractors' organizations show the greatest coöperation in dealing with the labor situation, and make the individual laborer legally responsible for wage contracts.

Track Creepage Stopped on Heavy Grades of Logging Railroads

METHODS used to overcome creepage or running of rail on heavy grades of logging railroads are outlined in papers by Fred W. Powers, of the Smith-Powers Co., Powers, Ore., and Fred Madigan, of Wilson Bros. & Co., Independence, Ore., presented before the Pacific Logging Congress at Portland, Ore., Oct. 8-11, 1919. The use of large timber dead men to which slotted rails are spiked, and the banking of rails with clay or gravel to maintain a more even temperature with a view to reduction in expansion and contraction, are the principal methods described.

Mr. Powers stated that the Smith-Powers Co. obtained the best results by spiking the rail to 8 x 16-in. timbers from 10 to 16 ft. long, used as dead men tightly tamped in and secured by bracing from banks or anchored to rock or concrete beds. If on a bridge, the dead man is bolted through the stringers with machine bolts. Slots, about 3 in. apart, are cut in the flange of the rail, on each side, to receive ordinary track spikes, fastening the rail securely to the anchored timber, as a slotted angle bar is spiked to ordinary ties at a joint. It was found that the number of dead men necessary varied according to grade, traffic, weight of rail, and condition of roadbed, but on some of the 6% grades timber placed "every few hundred feet" held the rail.

Creepage on a one-mile 7% grade with a 16° curve at the bottom was successfully overcome by Wilson Bros. & Co., according to Mr. Madigan, by banking the rails with clay and gravel, more readily to carry off the heat imparted to the rail by the rays of the sun and so reduce expansion and contraction which had consistently acted entirely in the direction of least resistance; namely, downward. On this grade it had been necessary to keep a gang of six men continuously at work during the summer months to repair distortion of track from creepage, and it was a common occurrence for the gang to have to realign the curve at the bottom of the hill after a loaded train had passed over it, before the empties could be returned.

It was recognized that the weight of steel itself on a steep grade is sufficient to cause running, but this was thought to be very slight as compared with the effect of a braked load going down the grade and presumably releasing a large portion of the force of expansion due to a rise in the temperature of the rail.

During the summer the rails were first heaped with clay, covering all but the ball of the rail. When the autumn rains started, gravel was substituted. Mr. Madigan reported that creepage troubles ended with the first use of clay, and that no money had been spent for maintenance since the substitution of gravel.

Oxygen in Steel

On account of the importance that frequently attaches to limiting the oxygen content of steel, it is of value to note from a recent study of the Bureau of Standards that "It is probably impossible to determine by the Ledebur method more than 25% of the oxygen present in steels as ferrous oxide." In these experiments, described in "Scientific Paper 350" by J. R. Cain and Leon Adler, mixtures of iron oxide and Acheson graphite were not reduced at 900° C. by the carbon in them when hydrogen was passed over at the rate of two liters per hour or faster.

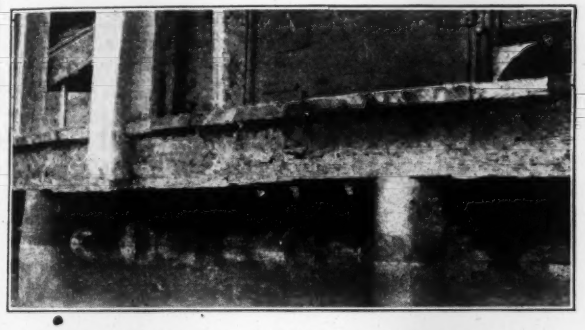
Pumping Station Undermined By Leaks and Shut Down

Stiff Clay Honeycombed by Rush of Water Under Low Head—Simple Repairs With Sheet Piles Enable Early Resumption

EXCESSIVE leakage through the foundation of a low-head centrifugal pumping station lifting water for irrigation over the bar from Utah Lake into the head of the Jordan River caused a shutdown Aug. 13, 1919, at a time when irrigators could least afford to be without water.

For more than 100 days every one of the centrifugal pumps working under a dropping head in the lake with a total lift varying from 0 to 7 ft. had operated continuously, although for some time the leak had been known.

So urgent were the demands for water that it was hoped the leakage would not increase sufficiently



BACKWASH OF 300 SECOND-FOOT CARRIED CLAY THROUGH THIS OPENING

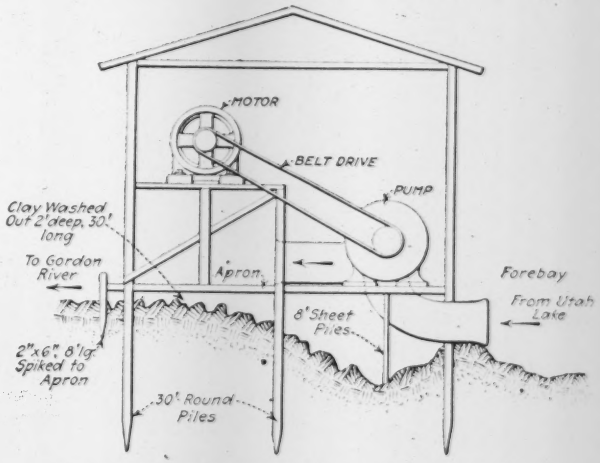
to endanger the structure before the season was over. When records indicated that 300 of the 800 sec.-ft. pumped were flowing back into the suction forebay, the superintendent felt that no further chance should be taken of the collapse of the superstructure of the station. After the pumps were stopped, a dike was thrown across a canal connecting the lake and the suction forebay.

The inlet and outlet pools were pumped out by means of hastily erected motor-driven centrifugal pumps discharging through wooden flumes. This was accomplished in less than 1½ days.

An inspection by a representative of *Engineering News-Record*, Aug. 15, in company with H. K. Burton, superintendent of the Salt Lake water-works, indicated an opening in the stiff blue clay 30 ft. long and 2 ft. deep directly under the wooden apron over which the pumps discharged. It appeared to converge to a deep hole, not unwatered, 15 to 20 ft. wide on the suction side.

By probing, the superintendent found that this hole did not extend much below the lower ends of a row of 8-ft. wooden sheeting under the pumps. A wagon-load of this sheeting was recovered. One of the photographs shows an opening 3 ft. high and about 20 ft. long between two of the suction pipes. These planks, which were spiked to the round piling supporting the structure, were torn off by the water. The round piles are 30 ft. long, and in no case were they undermined, so far as could be determined.

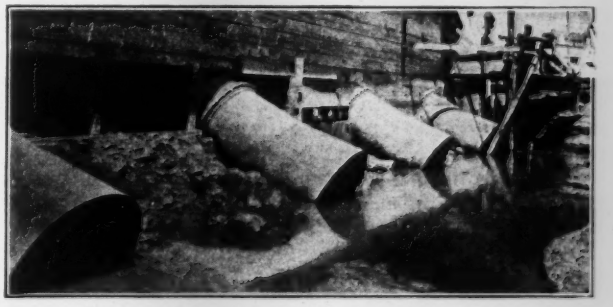
Since the supporting members, the round piles, were intact, and the superstructure showed no distress, a temporary expedient were determined upon. Sheet piles 8 ft. long, of 2 x 6-in. timbers, were driven by hand, directly in front of the plank apron over which the pumps discharge. The upper ends of these short piles were spiked to the apron. A penetration of 5 to 6 ft. was obtained, and it was believed that this barrier would



SKETCH SHOWING WASHOUT UNDER UTAH LAKE PUMPING STATION

hold back the bulk of the water for the six remaining weeks of the maximum pumping demand. The repairs were completed and pumping was resumed on August 18.

It is expected that the oldest portion of the station, which was built 17 years ago, entirely of wood, will have to be revamped. The later additions have concrete foundations and may be retained, although the



HONEYCOMBED CLAY UNDER APRON

question of installing screw pumps to obtain a higher efficiency is under consideration. The oldest units give 45% efficiency or less, and with the screw type it is hoped 70% efficiency over an extended range of the 0 to 7-ft. lift may be obtained.

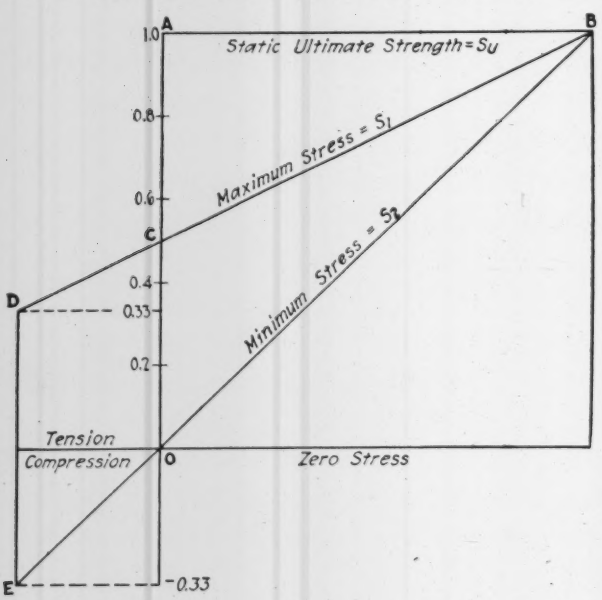
W. A. Knight is superintendent of operation of the pumping station and also acts under direction of the court as water commissioner, handling the distribution of the water to the canal companies. Salt Lake City owns one of the canals and exchanges the turbid warm lake water for potable mountain water. S. Q. Cannon, city engineer, is chairman of the board of canal company presidents employing Mr. Knight.

Broader Use of Johnson's Formula For Repeated Stresses

By J. B. Kommers
Assistant Professor of Mechanics, University of Wisconsin, Madison, Wis.

With the present state of our knowledge regarding the effect of repeated stresses on steel, the diagram suggested by J. B. Johnson, and often called Goodman's diagram, probably represents the facts better than any other diagram or formula which has been suggested.

Goodman's diagram is shown herewith. The values originally plotted by Goodman were for cases in which



GOODMAN'S DIAGRAM FOR REPEATED STRESS

the material had withstood from 4,000,000 to 10,000,000 cycles of repeated stress, in a few cases even more than 10,000,000. The length O A on the diagram represented the ultimate static strength of the material. The minimum stresses to which the material had been subjected were plotted as percentages of the ultimate static strength on a straight line, E O B. The maximum unit stresses to which the material had been subjected were then found to fall along the straight line D C B, so that point C represented 50% of the ultimate strength.

According to the law indicated by this diagram, when a stress is repeated from zero to a maximum value, the maximum value may be made 50% of the ultimate strength. If the maximum stress is greater than 50% of the ultimate, then the minimum stress must be made greater than zero if a large number of repetitions is to be withstood. If the maximum stress is completely reversed, then the stress may be 33% of the ultimate. As the maximum applied stress approaches the ultimate, the range of stress (that is, the algebraic difference between the maximum and minimum stresses) must be decreased.

It has been shown by J. B. Johnson, in "Materials of Construction," 5th edition, pp. 780-784, that according to Goodman's diagram the maximum stress to which the material may be subjected is given by the formula

$$S'_1 = \frac{\frac{1}{2} S_u}{1 - \frac{1}{2}\frac{S'_2}{S'_1}} \qquad (1)$$

in which

S'_1 = maximum unit stress which will cause failure after from 4,000,000 to 10,000,000 cycles of stress.

S'_2 = minimum unit stress applied during the cycle.

S_u = static ultimate strength of the material.

In order to determine to what extent experimental results check the construction of Goodman's diagram, and therefore to what extent formula (1) is justified, Table I (see next page) has been prepared. In this table are given the results of experiments on a great variety of ferrous materials, tested under various conditions. Only those results are given in which rupture took place after at least 3,000,000 cycles of stress had been applied.

The last two columns of the table give the maximum unit stress to which the material was actually subjected in the test, and also the maximum unit stress which the material should have been able to withstand according to formula (1). In those cases in which the material was subjected to a very high number of reversals it is to be expected that the unit stress in the test might be less than that given by the formula. The results show that in general the materials were able to withstand a higher stress than that calculated from the formula, which indicates that when the formula is in error it is in error on the side of safety.

The maximum unit stress as determined from formula (1) is the stress which for the given ratio of minimum to maximum stress would cause failure in from 4,000,000 to 10,000,000 repetitions. Moore and Seely (in *Proc. Amer. Soc. Test. Mat.*, 1916, Vol. 16, p. 470) have found that a decrease of 9% in unit stress doubles the number of repetitions required for failure. On this basis a factor of safety of 1.87 on the stress corresponds to an increase in repetitions of about 100 times, a factor of safety of 2.26 corresponds to an increase of about 500 times, and a factor of safety of 2.56 to an increase of about 1000 times. On this basis if formula (1) gave a maximum unit stress of 30,000 lb. per square inch (for a life of 4,000,000 to 10,000,000 cycles), then a stress of 11,700 should give a life of 4,000,000,000 to 10,000,000,000 cycles.

Formula (1) may be used, therefore, either by applying a factor of safety to the unit stress or by applying a factor of safety to the number of cycles for rupture. Based on the assumption that a decrease of 9% in unit stress doubles the cycles for rupture, a very simple relation exists between the factor of safety f based on the unit stress and the factor of safety f_1 based on the number of cycles: $0.136 \log f_1 = \log f$. This assumes that the unit stress varies with the number of cycles for rupture as a straight line when the results are plotted on logarithmic paper. It has been pointed out by Basquin (*Proc. Amer. Soc. Test. Mat.*, 1910, Vol. 10, p. 625) that when unit stresses are plotted against cycles for rupture on logarithmic paper a straight line will fit the points very well, at least up to about 1,000,000 cycles. Whether this relation holds for large numbers of cycles is in doubt because of lack of experimental evidence. However, one of Wöhler's steels subjected to repeated

TABLE I. REPEATED-STRESS TEST RESULTS COMPARED WITH FORMULA

Experimenter	Kind of Material	Kind of Test	Repetitions of Stress in Test	Ratio of Min. to Max. Stress in Test	Max. Stress in Test	Max. Stress by Formula
Bauschinger	Wrought-iron bars	Repeated tension	16,480,000	0	13.8	13.35
	Wrought-iron bars		9,310,000	0	17.2	13.35
	Steel axle		9,040,000	0	19.7	20.05
	Steel rail		10,190,000	0	16.4	19.5
	Steel rail		7,910,000	0	19.7	19.5
	Steel boiler plate		4,850,000	0	18.4	13.3
	Steel boiler plate		6,340,000	0	16.4	13.3
	Wrought-iron plate		5,170,000	0	7.1	12.6
	Wrought-iron plate		5,190,000	0	9.85	12.6
	Wrought-iron plate		5,180,000	0	16.4	12.6
	Mild-steel plate		6,680,000	0	16.0	14.25
	Mild-steel plate		3,550,000	0	16.0	14.25
	Mild-steel plate		7,350,000	0	16.0	14.25
	Wrought-iron bars		9,110,000	0	13.2	13.3
	Wrought-iron bars		7,400,000	0	16.4	13.3
Wöhler	Wrought-iron axle		10,141,645	0	15.28	10.15
	Wrought-iron axle	Repeated bending	4,035,400	0	17.18	10.15
	Cast steel		5,234,200	0	23.87	22.80
	Wrought-iron axle	Rotating beams	19,186,791	—1	8.6	7.1
	Wrought iron		3,930,000	—1	11.5	9.4
	Cast-steel axle		3,114,160	—1	15.3	15.2
	Cast-steel axle		4,163,375	—1	14.3	15.2
	Cast-steel axle		45,050,640	—1	14.3	15.2
	Cast-steel axle		20,467,780	—1	15.3	14.08
	Cast-steel axle		3,558,700	—1	13.4	14.08
	Cast-steel axle		3,275,860	—1	11.5	9.25
Baker	Rivet steel		14,876,432	—1	11.6	9.23
Haigh	Soft steel	Alternating direct stress	5,900,000	—1	13.2	8.93
	Soft steel		3,140,000	—0.39	17.06C	11.20C
	Soft steel		4,600,000	—0.097	20.7C	12.80C
	Soft steel		8,660,000	—0.077	20.25C	12.90C
Stead & Richards	Sorbitic steel, 0.44% carbon	Rotating beams	3,517,200	—1	25.0	18.37
	Steel, 0.36% carbon		4,400,000	—1	19.0	12.70
Rogers	Steel, 0.27% carbon		4,324,900	—1	20.0	34.63
	Steel 0.27% carbon (4 tests)		3,652,452	—1	40.0	34.63
	Steel, 0.32% carbon		7,615,035	—1	14.0	9.78
Watertown arsenal	0.26C steel	Rotating beams	27,546,930	—1	40,000	28,450
	0.26C steel		50,812,370	—1	40,000	30,350
	0.26C steel		19,578,810	—1	40,000	31,440
	0.26C steel		4,878,310	—1	45,000	29,650
	0.29C 5.7 Ni steel		4,368,400	—1	40,000	36,000
	0.29C 5.7 Ni steel		3,795,200	—1	40,000	41,580
	0.25C 4.5 Ni steel		3,296,700	—1	40,000	38,930
	0.66C steel		3,689,000	—1	40,000	42,580
	0.66C steel		4,323,600	—1	40,000	50,870
	0.25C steel		4,396,480	—1	45,000	34,130
	0.73C steel		7,264,010	—1	45,000	46,130
	0.82C steel		62,076,660	—1	35,000	47,600

NOTE.—Unit stresses are given in tons per square inch, except in the case of the Watertown Arsenal results, in which case they are given in pounds per square inch.

The stresses marked C were cases in which the maximum unit stress was compressive, instead of tensile.

bending gave a straight line up to 19,000,000 cycles. There is also some experimental evidence which tends to show that the straight line curve tends to bend to the right for large numbers of repetitions (number of cycles being plotted as abscissas). To assume that this straight-line relation does hold for large numbers of cycles, as will be done in this discussion, is an error on the side of safety.

The use of the formula for factor of safety will be illustrated by the solution of a problem. Suppose an axle subjected to reversed bending is to be designed on the basis of a life of 10 years, running at 300 r.p.m. for 10 hours every day in the year. This would mean about 657,000,000 revolutions. Moore and Seely are of the opinion that a multiplier of 100 is not too large to use on cycles for rupture as a factor of safety. This would make 65,700,000,000 cycles for the present case. Formula (1) is based on stresses which cause failure in from 4,000,000 to 10,000,000 cycles. In order to be conservative it is recommended that a value of 5,000,000 cycles be assumed to cause failure for all stresses taken from Goodman's diagram. This, in the present case, gives a factor of safety of 65,700,000,000 ÷ 5,000,000, or 13,140. The logarithmic formula for factor of safety gives the corresponding factor of safety based on unit stress as 3.63. If a nickel-steel shaft is used having an ultimate strength of 120,000 lb. per square inch, formula (1) gives a unit stress of 40,000 lb. per square inch, the ratio of minimum to maximum stress being —1. Dividing this stress by 3.63 gives an allowable unit stress of 11,020 lb. per square inch.

In order that the amount of computation required for any problem may be reduced to a minimum, Table II has been prepared. From this table the factor of safety to be used on S'_1 may be read off when the number of cycles is known. Taking the value of S'_1 from formula (1) and then dividing by this factor of safety will give the proper allowable unit stress.

TABLE II. FACTORS OF SAFETY ON STRESS FOR VARIOUS LENGTHS OF LIFE

Number of Cycles of Stress Causing Failure	Factor of Safety to be Used in Stress from Formula (1)
100,000,000,000	3.85
90,000,000,000	3.78
80,000,000,000	3.72
70,000,000,000	3.67
60,000,000,000	3.59
50,000,000,000	3.49
40,000,000,000	3.39
30,000,000,000	3.26
20,000,000,000	3.08
10,000,000,000	2.81
9,000,000,000	2.77
8,000,000,000	2.72
7,000,000,000	2.68
6,000,000,000	2.62
5,000,000,000	2.56
4,000,000,000	2.48
3,000,000,000	2.39
2,000,000,000	2.26
1,000,000,000	2.06
500,000,000	1.87
100,000,000	1.53
50,000,000	1.37
10,000,000	1.10
5,000,000	1.00

Certain precautions should be kept in mind in using values of S'_1 obtained from formula (1). Bairstow found that when a cycle of stress was applied to a specimen in which the tensile unit stress was numerically greater than the compressive stress, a permanent elongation took place, even when the maximum unit stress was less than the static elastic limit of the material. For this reason no value of S'_1 should ever be

used as an allowable unit stress unless it is well within the elastic limit of the material.

In connection with Goodman's diagram it should be noted that when the stress is partly reversed the stress which is numerically greater is called the maximum unit stress, the other being the minimum.

Moore and Seely (*Proc. Amer. Soc. Test. Mat.*, 1915, p. 438; 1916, p. 471) have proposed certain formulas for determining a safe unit stress to use for materials subjected to fatigue. A comparison of results from their formulas with the methods advocated in this article will be of interest. Table III compares results

TABLE III. ALLOWABLE STRESS FOR LIFE HAZARD

	10,000,000 Repetitions		10,000,000,000 Repetitions	
Ratio of Minimum to Maximum Stress	Moore and Seely	Kommers	Moore and Seely	Kommers
0.8	161,700	45,400	70,250	17,800
0.6	80,800	39,100	35,100	15,300
0.4	53,800	34,100	23,400	13,350
0.2	40,300	30,300	17,580	11,850
0	32,300	27,300	14,050	10,680
—0.2	26,900	24,700	11,700	9,680
—0.4	23,100	22,700	10,030	8,900
—0.6	20,200	21,000	8,780	8,220
—0.8	17,950	19,550	7,810	7,650
—1.0	16,150	18,200	7,025	7,120

(*Proc. Amer. Soc. Test. Mat.*, 1915, p. 438; 1916, p. 471.)

with the formula which they recommend for cases in which failure would endanger life, and Table IV compares results with the formula which they recommend for cases in which failure would not endanger life. The comparison is made for structural steel of ultimate strength 60,000 lb. per square inch.

It will be noted that in both the above tables the results for reversed stresses (negative ratios) agree very well, although the formulas of Moore and Seely were arrived at by a method quite different from that

TABLE IV. ALLOWABLE STRESS FOR ORDINARY HAZARD

	10,000,000 Repetitions		10,000,000,000 Repetitions	
Ratio of Minimum to Maximum Stress	Moore and Seely	Kommers	Moore and Seely	Kommers
0.8	185,000	45,400	88,000	17,800
0.6	91,000	39,100	44,000	15,300
0.4	61,000	34,100	29,500	13,350
0.2	46,000	30,300	22,000	11,850
0	37,000	27,300	17,800	10,680
—0.2	30,000	24,700	14,300	9,680
—0.4	26,000	22,700	12,500	8,900
—0.6	22,500	21,000	11,000	8,220
—0.8	20,000	19,550	9,800	7,650
—1.0	18,300	18,200	9,000	7,120

used by the author of the present article. For unidirectional stress, however, the results do not agree. It is seen that the formulas of Moore and Seely in a number of cases give values which are considerably higher than 60,000 lb. per square inch, the ultimate strength of the material. These results seem to indicate that for the larger plus values of the ratio of minimum to maximum stress the formulas are incorrect.

Soaking in Salt Lake Increases Life of Ties

When the Southern Pacific R.R. has ties that are to be stored anywhere in the vicinity of Salt Lake, Utah, it is the custom to put them into the lake and allow them to soak. It has been found that the high salt content in the water acts as a preservative and materially lengthens the life of the tie when used in an arid climate. This has been done for some years. It was begun when engineers of the company noted that Oregon fir piling lasted indefinitely in these waters. A "pickling pool" was accordingly selected, and ties are left in soak for a year or two whenever it is found convenient to do so.

County in Michigan Saves $10,000 on Own Pebble-Washing Plant

WHAT amounts to 400% gross profit on its investment has been realized by Wayne County, Mich., in the installation and operation of its pebble-washing plant at Northville, Mich. Instead of paying $2.25 per cubic yard for commercial pebbles to use on the Northville concrete paving job, by operating its own plant Wayne County has paid but 53c. per cubic yard, according to figures included in the recent report of the Board of County Commissioners. Approximately 10,000 cu. yd. of material will be taken out of the Northville pit. Cost of the plant was approximately $7,200 and daily operating expense is approximately $76—gravel loaded on industrial cars ready to haul—so the net saving on the Northville job alone is $10,000.

Wayne County entered into its own pebble-washing scheme because of the great possibility of being held up for shipments of pebbles and sand through railroad congestion and on account of the poor yard facilities at Northville. A gravel pit was leased at 15c. per cubic yard in the bank, measurement to be governed by the number of cubic yards of concrete laid on the Northville and Fishery Road jobs—the only two jobs upon which gravel from the Northville pit was to be used. An industrial railway was laid right up to the chutes from the washing-plant bins. A small stream fed by local springs furnishes an abundant supply of water, which is pumped 1,000 ft. through two lines of 3-in. pipe to the washing plant by electric motor. Three-inch pipe was used because it was in stock. The plant is operated by a small electric motor.

The average daily output has been 200 cu. yd., the total daily cost of this production being $76, distributed as follows:

Four teams, $8 each	$32.00
Two scraper holders, $5 each	10.00
One foreman, $6.50	6.50
One operator, $6	6.00
Two carloaders, $5 each	10.00
Motor rental	1.50
Electric current (estimated)	10.00

Adding the 15c. per yard for the cost of the material in the pit, a total cost of loading the gravel on industrial railway is 53c. Additional saving might have been made by the installation of a dragline bucket and hoisting engine, but owing to the short run which the plant will have it was not considered advisable to invest in so expensive equipment.

Commercial pebbles cost $1.25 per ton f.o.b. cars at Northville, plus about 25c. per ton to unload into industrial cars, making a total of $1.50 per ton, or $2.25 per cubic yard.

Wayne County expects next year to operate the plant for a few months to furnish maintenance gravel for the 24 miles of gravel road from Detroit to Plymouth and Northville.

Responsibility for Water-Main Break Damages

Responsibility for damages to breaks in water mains due to the increased pressure caused by the introduction of Catskill water has been placed on New York City by the Appellate Division of the state Supreme Court. The decision, which is subject to appeal, is printed in the September *Journal of the American Water Works Association*.

Side Hill Loading Plant for Concrete Road

Batch Boxes Successfully Charged Through Bottom Gates in Horizontal Storage Platform Built Out From Hillside

UNUSUAL details in central proportioning plant operation and in batch-box arrangement have been developed in constructing the 5½-mile concrete road from Martins Creek to Bangor, Penn. Free discharge of stone and sand from flat-bottom bins is insured by using the unloading crane to shift the material in the bins; manual handling of cement bags is greatly lessened by roller conveyors; all measuring is done in the batch boxes; three-compartment batch boxes keep sand, stone and cement separate, and a close cover for the cement compartment insures a dry cement.

Officially, the improvement is Route No. 165, Northampton County; it is a portion of the main route between Philadelphia, the Delaware Water Gap and the Pocono mountain resorts. Its length is 28,791 ft., or a trifle less than 5½ miles. The slab is 18 ft. wide and 6 in. thick at the edges, and is reinforced with a mesh weighing 25 lb. per 100 sq.ft. A 1:2:3 concrete is specified. Premolded expansion joints were spaced every 50 ft. at the beginning of the work, but later this spacing was changed to 500 ft. to tangents and at the beginning and end of vertical and horizontal curves, but not closer than 100 ft. Vertical contraction joints, without expansion, are placed wherever work is stopped for the day. Generally speaking, the construction is side-hill work calling for a considerable volume of excavation, largely in rock.

Advantage was taken of the sidehill in locating the loading plant, as indicated by the view, Fig. 1. Sand and stone delivered by railway are unloaded by a locomotive crane, running on a parallel track and operating a 1-cu.yd. clamshell, into the storage bins. These consist of a platform built out from the crane-track level overhanging the slope and supported by a timber framework; the ends and the outer edge of the platform have plank sides. Holes with 12 x 12-in. iron chutes, controlled by gates, were provided in the bin bottom for charging the batch boxes on cars running underneath the bin. There are five chutes for stone and four for sand, and they are so spaced as to discharge vertically into the proper batch-box compartments. No difficulty is experienced in securing a free flow through the chutes when plenty of material covers them, and when a chute becomes uncovered the crane shifts material from other parts of the pile to cover it again.

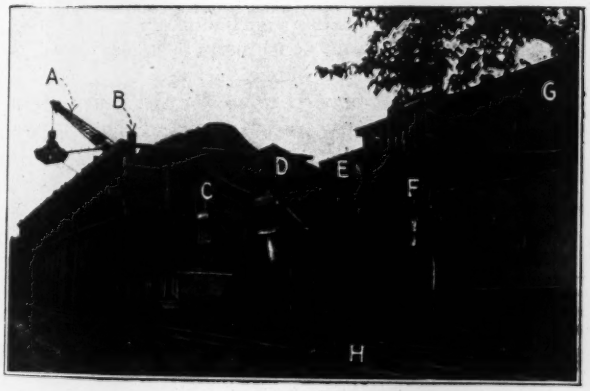


FIG. 1. ARRANGEMENT OF BINS, CHUTES AND TRACK FOR PROPORTIONING BATCHES

A, unloading crane; B, gravel and sand bin; C, cement chute; D, cement chute; E, railway track; F, cement chute; G, cement house; H, industrial railway

Cement is shipped in bags. When cars are in and concreting is in progress the bags are delivered directly from the car to the charging chutes shown by Fig. 1. Delivery is by a roller conveyor which extends from the car through the cement house to the chute. If paving is not in progress, the bags are removed from the conveyor at the cement house and stored. The conveyor has 18-in. rollers. When bags are being delivered to the chutes they are placed on the conveyor with the tie end uphill, so that they may be untied as they move downward and be ready for emptying when the chute is reached.

FIG. 2. INDUSTRIAL TRAIN DUMPING AT MIXER

Transportation of materials to the mixer is by six-car trains hauled by three-ton gasoline locomotives on 24-in.-gage industrial track. Especially heavy cars with 7-in. channel sides, roller bearings, spring journals and spring drawbars are used. Each car carries two batch boxes of three compartments each, holding respectively 12 cu.ft. of stone, 8 cu.ft. of sand and 4 cu.ft. of cement. The cement compartment carries a cover as protection against rain. In this connection the superintendent of the work suggests that the whole box be covered, as when rain water collects in the bottoms of sand and stone boxes it is likely to work through into the cement and damage it. Proportioning is accomplished by filling the respective compartments as the train passes under the aggregate bins, and by the cement chutes.

At the mixer the batch boxes are lifted from the cars by a mixer crane and dumped into the charging skip by tilting. The slab is compacted and finished by machine tamping.

Grade preparations for this road required rather heavy rock excavation, partly in through cuts but in large part in side-hill cuts. The volume of rock excavation was 19,520 cu.yd. of limestone, shale and slate. A wagon compressor supplied the air for drilling. After blasting, the rock was loaded by steam shovel into wagons and hauled to dumps. With two drillers, one helper and a foreman, 145 ft. of hole per day was drilled. The maximum depth of hole was 12 feet.

The contract for this improvement was let to McArthur Brothers Co., New York, for $320,000. Alfred H. Sauerbrun is superintendent for the contractors. The work is under the supervision of the Pennsylvania State Highway Department, W. D. Uhler, chief engineer, and W. R. Wolfinger, district engineer. George D. Evans was chief inspector.

Resistance of Soft Clay to Penetration By Pyramids and Piles

A NEW attack was made on the subject of the mechanical properties of clay and its resistance to penetration—that is, its load-carrying power—by A. S. E. Ackermann in a long series of laboratory experiments reported in a paper read before the Society of Engineers (London) last March and printed in the society's "Journal" No. 2 of 1919. The experiments, made on London clay puddled to a very soft condition, tend to show that the material experimented with was elastic; that at a definite pressure, varying with the temperature and the percentage of water, it flowed like a viscous fluid; that tapered piles in clay will support more load per unit of volume than straight piles; that side friction is the main factor in pile supporting power; and that pointed piles are more efficient than blunt piles.

All the work was done on laboratory scale. In the experiments with square pyramids, two tapers were used; one pyramid measured 6½ in. square at the base and was 9½ in. high (half angle 18° 47′), while the corresponding dimensions of the other were 2⅝ in. and 15½ in (half angle 4° 57′). Rods or "piles," of diameters from $\frac{11}{16}$ in. to 2½ in., were used, sometimes with square end, sometimes fitted with a point; and tapered piles, truncated pyramids and round disks were also tried. In each case the test object was forced down into the clay by a loading and guide rod, passing through a guide some distance up, and loaded at the top by weights placed on a self-centering carrier. The load was increased by small increments, and the downward movement of the rod was measured when it had come to rest.

The clay contained from 27.8 to 39.6% of water in the various experiments. A coal scuttle was used as a container, so that only moderate penetrations could be reached. Its elasticity was shown by a torsion experiment, made on a rolled specimen about ¾ in. by 27 in. suspended by one end and twisted by means of a crossbar at the lower end to an angle of 37½°; this rod recovered to a set of 5½°, and on repeating the twisting and holding it for 5 sec. it recovered the full 32° of twist within 2 sec., indicating an acquired complete elasticity.

With the pyramids, the load varied as the square of the penetration but directly as the area of contact between the test object and the clay. In the pile experiments the plot of load against penetration curved to the right, tending ultimately toward a sloping straight line. This, it was concluded, was due to the combination of base and friction effects; by measuring the former, using a thin horizontal disk in place of a pile, and subtracting the resistance of the disk from that of the pile, nearly straight-line plots were obtained. The computed mean surface friction (on wood) was found to vary greatly with both water content and temperature of the clay, and in addition proved to be greater for a pile of small diameter than for one of large diameter. At a water content of 29% and at 45° to 47° F., a 1-in. pile had a surface friction of 0.72 lb. per square inch, and a 2½-in. pile a friction of 0.45 lb. per square inch. Comparison experiments for straight and tapered piles showed larger friction values for the latter than for the former, even with only 1.6% taper; the advantage of the tapered pile was still greater when expressed as load carried per unit of pile volume. While the results were quite variable, the author gives a figure of 24.7 as expressing the advantage of a tapered pile over a pointed straight pile (35-mm. square pile compared with tapered square pile 36 mm. and 18 mm. at ends.

Flat horizontal disks forced down into the clay gave load-penetration curves tending to become horizontal. "At certain critical loads the disks started, and continued without additional load to sink comparatively rapidly into the clay." Considering that under the critical load the clay directly under the disk acquires the nature of a viscous liquid, the author computed the "pressure of fluidity." At 29% moisture it was about 1200 lb. per square foot, the values for disks 1 to 2½ in. in diameter being in close agreement. These loads were reached when the disks had been forced about 4 in. into the clay, lower pressures sufficing for penetrations of lesser amount. The "pressure of fluidity" decreased rapidly with increasing water content of the clay, falling to 750 lb. per square foot for 31%, 500 lb. for 33%, and 250 lb. for 37% of water content. As even the highest of these values is very far below any footing pressure in clays ordinarily utilized for foundations, it is evident that the material experimented on was an abnormally soft clay.

Service of Motor Truck During British Railway Strike

POSSIBILITIES of the use of heavy motor vehicles, particularly to relieve congestion at docks and railroad terminals in London, were revealed in the recent strike in England. A description of this forced investigation of the economy and utility of heavy haulage by truck is given in *Commerce Reports* by Trade Commissioner Henry F. Grady of London. According to Mr. Grady, Great Britain's conclusion upon the settlement of the strike was that motor vehicles have invaluable possibilities for public service.

The three biggest opportunities for the heavy motor vehicle, according to Mr. Grady's report of the situation, lie in the evacuation of docks and railroad terminals, and in the transport of farm and dairy produce to the marketing centers. During the strike the motor vehicle appeared to have been specially useful in the collection and distribution of food. Much less handling, meaning a great deal less warehousing, of food is necessary when shipped by truck.

No adequate consideration can be made of the running cost of motor transport during the strike because of the abnormal conditions under which the transport service was initiated. The main advantage gained was proof that the community could call upon an alternative service, far more efficient and abundant than it was supposed to be. According to the London *Times*, the more efficient motor vehicles used by the government—which operated a maximum of 25,000 vehicles during the strike—were capable of running from 8 to 9 mi. on a gallon of gasoline. However, the average was 6 mi. per gal. Lubricating oil, labor, and depreciation brought the cost per ton-mile to a fairly heavy figure. The Ministry of Food charged traders for transport service 12c. per ton-mile. The motor correspondent of the *Daily Telegraph* gives the following as the highest figures that the road transport firms of

Great Britain charge today per ton-mile: One-ton vehicle, 35c; two-ton vehicle, 54c.; three-ton vehicle, 72c.; four-ton vehicle, 84c.; five-ton vehicle, 96c. These figures give a profit to haulage firms, provided the mileage run per day averages 60.

In the case of dock congestion the Port and Transit Committee of London consider that the cost of transport will be more than offset by limiting the enormous loss which results from the detention of ships unable to discharge cargoes. A big London drygoods house, says Mr. Grady, estimates the cost of handling its goods by rail at from $5.66 per ton for class 1 merchandise to $11.40 per ton for class No. 5 merchandise. In contrast with these costs, road transport charges would work out at not less than $10 a ton, and if the trucks were not loaded both ways, $20 per ton. The economic aspect of motor transportation cannot be arrived at, it is said, until an analysis is made of statistics and the actual cost per truck-mile is ascertained.

Effect of Deferred Earnings on Capital Value

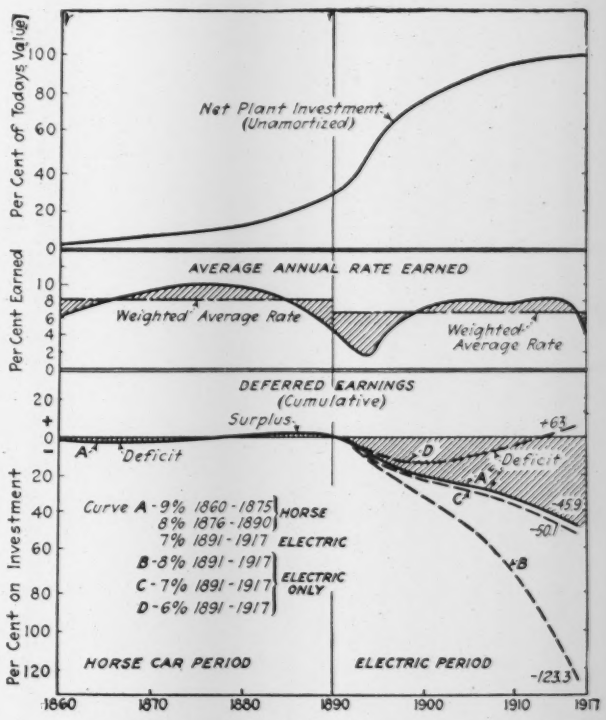
James R. Bibbin, in Paper Before Western Society of Engineers, Shows Cumulative Result of Small Net Returns

THE effect of cumulative deferred earnings on the capital value of a public utility, the effect being brought about by net returns less than current interest rate on unamortized investment, is pointed out in a paper presented before a September meeting of the Western Society of Engineers by James R. Bibbin, of the Arnold Co., consulting engineers, Chicago. An actual example of an electric-railway company is used to illustrate the principle of an aggregate deficit extending over a period of years, showing that a total deficit of nearly half the value of the property has been brought about in less than 30 years, although there have been apparent net returns annually.

The discussion is based on the theory that all periods of a property's history—past, present and future—must be considered in any determination of true status. Corporate deficits must be financed, and it is assumed that such deficits were financed, during the slumps, on money borrowed at current rates of interest. Similarly, surpluses, when they occurred, are assumed to have been put immediately at interest and credited at the same rate. Thus, the zero-line of surplus-deficit, as indicated in the lower portion of the accompanying diagram, indicates what may be termed "par" on the money market with respect to true operation and without reference to stocks and bonds.

The investment history of the company in question begins with the time of the Civil War, when a few horse-car lines were operated, and extends to 1917. The period of electrification began in 1890, when the property investment was but one-third the investment in 1917, the most rapid rate of increase occurring between 1891-1896, when the rate earned dropped rapidly, as shown in the diagram. Thus, a deficit, below the normal current interest rate, occurred, and is represented in the lower portion of the chart as cumulative deferred earnings.

A definite money rate is assumed (for example,



INVESTMENT HISTORY OF A PUBLIC UTILITY

from 1860 to 1875, 9%; from 1876 to 1890, 8%, and from 1891 to 1917, 7%) in accordance with which the property should have made earnings applicable to interest only, carrying forward each year the resulting surplus and deficit, as the case might be, to a cumulative total as of the date under consideration. At these rates, this property actually showed an aggregate deficit, or deferred earnings, amounting to nearly one-half (45.9%) of the existing plant investment in 1917. The horse-car period practically sustained itself at par up to 1890, when electrification on a large scale began, and unamortized investment increased accordingly. Closing with 1917, the curve of cumulative deferred earnings is downward, indicative of future conditions.

Output of Mineral Products in 1918

According to a preliminary report on the mineral production of the United States in 1918, based on figures compiled by the United States Geological Survey, the production of mineral components of building material, such as clay products, building stone, cement, lime and gypsum, showed a great decline from the output for 1917. The total value of all minerals produced was approximately $5,500,000,000, more than $500,000,000 in excess of the value recorded for 1917, but the total quantity produced was less. The output of fuels was greater than in 1917, though somewhat less anthracite coal was marketed. The increase in the quantity of coal marketed was about 5%, but the increase in value, due to higher prices, was more than 17%. It is significant that although the increase in the quantity of petroleum marketed was only a little more than 4%, the increase in value was over 32%. The value of the metals produced was about 3% greater in 1918 than in 1917.

Economic Values in Sewage and Sewage Sludge

The great difficulties incident to the recovery of grease and fertilizer from sewage, and the possibilities of attaining that end by a modification of the Cobwell process of garbage treatment, are reviewed in the following slightly condensed paper read before the American Society of Municipal Improvements, Nov. 12, 1919, by Raymond Wells, chemist and technologist, Homer, N. Y. The chief hope held out by Mr. Wells is that cities may contribute to the conservation of grease and fertilizer base while getting rid of their sewage sludge after it has been produced, rather than that they may expect to get much, if any, revenue from it, at least in the immediate future. Mr. Wells has played an important part in the development of the Cobwell process and writes also from the viewpoint of a purchaser of grease.—EDITOR.

VAST quantities of valuable materials are present in sewage, but so great is the dilution that methods of recovery readily applied in other waste reclamation are not applicable to sewage or sewage sludge.

Partial elimination of moisture by filter-pressing or centrifuging, followed by drying, would seem to be the simplest method of putting sludge into a valuable form. But, unfortunately, the almost colloidal character of the precipitate, and the amount of grease and metallic soaps contained, render pressing and centrifuging below 75-80% of moisture a difficult task. The subsequent evaporation of so great an amount of water in any type of dryer is most expensive, and odors given off are extremely disagreeable. Furthermore, in direct-heat dryers, the volume of gases of combustion, together with the moisture-saturated air, is so great as to preclude any thought of condensing or scrubbing out the odors. For this reason alone, aside from the difficulties encountered in drying such a material, it is difficult to see any hope of solution in this direction. Moreover, the dried residue or tankage obtained by this method, while having considerable manurial value, is in a most undesirable condition for use as fertilizer or fertilizer-base goods.

GREASE LESSENS FERTILIZER VALUE

This is due to the grease contained which, when it exceeds 8% in any tankage, renders its assimilation by the soil extremely difficult. Really, to complete the cycle of operation, the dried sludge should be percolated, the grease removed and the percolated tankage redried. Since, however, a large percentage of the grease present is in combination with alkaline earth and heavy metals in form of metallic soaps, it renders solution by simple percolation impossible. For this reason it is necessary to acidulate the sludge, prior to percolation, with some mineral acid, so that the fatty acids combined with metals as soaps will be liberated and put in such condition that they will be soluble in the usual solvents employed in percolation. This acidulation would have to take place prior to the drying operation, in suitable lead-lined digesting apparatus, and no matter how carefully this operation were carried out, the wear and tear on the drying apparatus and the percolator, due to acid action, would render the operation very expensive and troublesome. Not only would the appartus employed be very short-lived, but the action taking place between the liberated fatty acids and the grease in immediate contact with even a trace of mineral acid at high temperature would crack the fatty materials so badly as to render them valueless. This was very evident in attempts by the writer to handle samples of sludge made by the Miles-acid process, by direct drying. At a certain point where most of the moisture was eliminated, charring took place with copious evolution of sulphur dioxide and acrolein vapors, and the grease obtained by subsequent extraction and distillation gave an extraordinary amount of tar and unsaponifiable matter. Not only does this reaction take place in the drying operation, but the solvent carrying the grease also carries with it small traces of mineral acid, which must be carefully washed and settled out before distillation for recovery of solvent. If this is not done, upon approaching a certain concentration in the still, violent foaming with evolution of sulphur dioxide and fatty decomposition products takes place, and again the grease is damaged. It may be well to note that the mineral acid referred to is of course, sulphuric acid, no other acid being available, on account of price, for use on such low-grade raw material. For these reasons, the operation of drying, percolating, redrying, etc., so readily applied to other materials, seems not to be very successful when used on sewage sludge.

THE DEWATERING PROBLEM

Destructive distillation of the dried or semi-dried sludge has been attempted, with the usual methods of recovery of the ammoniacal liquors and oils. Here again the problem of moisture elimination is intruded, and the recoveries made are not such as warrant the hope of even paying for the operation, much less of showing any profitable return. In both the cases of distillation of dried sludge and of garbage tankage, the experiments of the writer have in all cases failed to show a greater recovery of nitrogen in the ammoniacal liquors than 35-40% of that present in the original samples. As a rule, an additional 30% remains in the retort charcoal, with the residue passing off as nitrogen in the combustible gases. The oils passing over are of little value except as fuel. This seems to the writer a very expensive way of producing fuel oil.

Acidulation of semi-dried sludge from filter-presses or centrifuges, followed by drying in retorts, with subsequent distillation in current of superheated steam, to carry over the fatty acids liberated by acid, has been tried, but found unsatisfactory for many reasons.

Methods have been described and tested out on a large scale, attempting the direct extraction of greases from wet sludge by volatile solvents. In these processes, which are difficult and expensive to carry out, a partial solution of the free grease results, together with a portion of the waxes existent in sewage, and of soaps. The result is the formation of extremely resistant emulsions, which seem to defy any recovery treatment by distillation. After such an emulsified mass has reached a certain concentration in the solvent recovery stills, the whole charge expands into a foamy mass, in which, seemingly, a gallon will fill a large tank.

An endless number of methods and schemes have been tried first and last, but apparently none had sufficient merit to survive the first attempts. Possibly many failed under market conditions which do not exist at the present time, or, what is more likely, at their

beginning they promised so much that mere partial success gave nothing but discouragement.

Leaving the recovery method aside for the moment, has sewage sludge any inherent values, and, if so, what are they? What type and condition of the sludge offers the greatest possibilities?

What Is the Value of Sewage Sludge?

Setting aside for the present the moisture content, the value of the sludge will be governed by its grease and nitrogen content, since, while all sludges contain small percentages of bone phosphate and potash, from a practical standpoint they may be neglected.

Consider the following analyses (dry basis):

	Ammonia, Per Cent.	Grease, Per Cent.
Baltimore sludge, acid process, fresh	3.26	27.23
Boston sludge, acid process, fresh	3.91	29.30
Chicago Sanitary District, activated, fresh	5.10	14.70
Pleasantville, N. Y., settling basins, one month in basin	4.14	27.40
Syracuse, settling basin, fresh	4.92	9.60
Syracuse, activated, fresh	5.06	17.70

All of the analyses are from samples of sludge produced from comparatively fresh sewage and are representative of sludge rapidly deposited and not allowed to rest in the tanks for any great length of time. For that reason little bacterial action had taken place, and the ammonia and grease content were at their maximum for the different types of sludge. Compare with these the analyses of samples of sludge from so-called septic tanks or sludge which has been exposed for a great length of time on drying beds:

	Ammonia, Per Cent.	Grease, Per Cent.
Baltimore sludge from tanks, on bed approximately six months	2.24	1.50
Chicago activated, nine months old	4.40	5.00
Akron, O., three months in tank, six months on bed	1.00	6.00

All other things being equal, the value of a sludge for byproduct recovery purposes depends upon the shortest possible period of tanking and shortest elapsed time between tank and ultimate utilization. In other words, bacterial action and weather erosion must be restricted to a minimum. This is directly contrary to usual sewage practice and is one of the rocks on which the disposal proposition has stumbled. Below a certain minimum of recoverable values, there is no use attempting recovery. This minimum seems to be for low-grade ammoniates, such as garbage tankage and sewage sludge, approximately 3% ammonia. Below this the expense of handling and freight cost put it out of all hope of competition with other and more concentrated materials. From an economic and business standpoint, any goods falling below this rating had better be forgotten and no time wasted on developing methods of handling.

Moisture Content of Sludge Vital

Moisture content of sludge leaving tanks is the next most vital consideration. In order to come within economic range of any method of artificial drying of any material containing 3% to 3.5% ammonia and 10% to 15% grease on a dry basis, moisture must not exceed 75% to 80%. All sludges as they come from tanks or basins are far above this, and activated sludge way beyond. Sludge from ordinary sedimentation basins can be drained and air-dried within several weeks to 77% to 80% moisture, and by centrifuging to about the same amount. It would appear, however, that the simplest and most inexpensive method is that of depositing sludge after removal from tanks on drainage beds, exposed to atmospheric drying conditions. In any case, without the presence of water dumping facilities, the sludge must be partially dewatered before final disposition.

With sludge containing 75% moisture the ultimate disposition with byproduct recovery is not impossible, though difficult and presenting many curious conditions.

To accomplish the disposal with production of a marketable tankage and grease, the elimination of all of the moisture with subsequent extraction of the grease by volatile solvents, a system of drying, extraction and recovery in one operation is suggested. Such a combined and complete operation is carried out at the present time only by the Cobwell process.

This process, as is doubtless well known, is applied to municipal garbage, dead animals, slaughter-house offal and other wet organic waste materials. At the request of several engineers and municipal officials, a number of small-scale and several large-scale experiments have been made on sewage sludge, with results which seem to warrant some hope of solution of the problem.

Simultaneous Dehydration and Degreasing

In this method of dehydration with simultaneous degreasing, the principle employed is that of desiccation in a hot bath of an immiscible solvent, which shall serve not only as a dehydrating medium but shall also during the period of drying continually dissolve the grease contained in the material to be dried. Such a solvent, preferably employed in the handling of sewage sludge, is a high-boiling petroleum naphtha, distilling within the range 360° F.-420° F., which corresponds to the first 60-70% over in the fractionation of "standard waterwhite kerosene." This material serves not only as the most economical heating medium, but, owing to the high temperature maintained in the desiccating mass, serves to remove or dissolve the metallic soaps as well as the free grease. Cold or merely warm solvents of a less oily nature have little solvent action on such soaps, but high-boiling oils, particularly when carrying small quantities of grease, are able to dissolve them without difficulty. Upon cooling they are apt to be deposited as jelly-like masses or to cause the gelatinization of the whole solvent solution, and for that reason the solution must be treated, before entering the recovery stills, in such manner that the soaps are decomposed and a solution of clean, fatty acids results. This treatment will be taken up in order.

The principal apparatus consists essentially of a closed tank, circular in shape and of a diameter three times the height. Jackets are provided on the bottom and well up the sides, so that as much available heating surface is obtained as is possible. Through the bottom, oblong, screened openings are provided for the withdrawal of solvent and grease and for pumping in solvent during the cooking or desiccating operation. Within the tank proper is a central shaft, provided with two sweeps set very close to the bottom, in such manner that they shall slide under the mass to be treated, imparting an undulatory motion, without cutting through the mass itself. For this reason very little power is required. The tanks are of shallow form, in order that the amount of heating surface in proportion to the mass to be treated may be as great as possible. Greater height and capacity could only be obtained at the expense of operating time and greater consumption

of power. The top of the tank is provided with a charging manhole and an outlet pipe for vapors to pass to the condenser.

After the tank is loaded with sludge the charging manhole is securely closed by the swing cover, solvent is admitted through the bottom screens, sufficient to immerse totally the mass of sludge, and steam is turned on the jackets. Combined vapors of solvent and water vapor pass out through the vapor line to surface condensers of suitable capacity, and in these the mixture of solvent and water vapor is condensed to a liquid, which leaves the tail pipe of the condenser and passes to a separating tank where, by virtue of the lighter gravity of the solvent, separation of solvent and water is effected. The solvent flows to storage for re-use. Owing to rapid evaporation, the solvent level is lowered in the tank, and a further quantity is pumped in.

Four to five hours are required for the evaporation of all of the water, and at this time, through the sight glasses, the dried fiber, etc., can be observed floating on the top of the solvent. At this point the agitator is stopped, the steam turned off, the drain valves opened and the grease-laden solvent pumped. Several washes with fresh solvent complete the degreasing of the mass, which is then heated, and agitated and, with the help of live steam, freed from the absorbed solvent.

Treatment of Grease-Laden Solvent

The solvent, carrying with it the extracted grease, soaps, etc., must receive preliminary treatment before passing to the solvent-recovery and grease-finishing stills. This treatment is carried out in a lead-lined tank provided with an agitator. To the solvent is added a sufficient quantity of sulphuric or muriatic acid and water to decompose completely the metallic soaps present. The acid water is well churned up with the solvent, and allowed to settle and drained off; fresh water is added and mixed, allowed to settle, and the clear grease solvent solution is run to the recovery stills. By this treatment, foaming and other difficulties are avoided in the distillation, and the grease recovered does not form the emulsions, separated with difficulty, it is disposed to form. Such grease can be cleaned up and settled free from mechanical impurities and moisture, without undue trouble.

The entire cycle of operations takes place in a closed circuit, and the only vent for noncondensible gases for the whole system of tanks (or reducers), condensers, separating tanks, washers, stills and storage tanks, is on the final solvent storage tank or tanks. This vent exhausts through an oil scrubber to recover traces of naphtha carried over by carburetting. During no period of the operation is the sludge exposed to the air or man-handled in any way, until it is finally discharged from the side door of the tank in a dried, degreased condition. The only places where odors or noxious effluent are exposed to the air and liable to cause an insanitary and nuisance condition, is at the gas vents on the storage tanks and at the effluent overflow on the separating tank. This effluent is, of course, distilled water from the sludge, and carries with it the odor of the sludge, which in the case of fresh sludge (and that is preferably handled) is very offensive. The quantity of this water equals that contained in the sludge prior to desiccation and the condensed steam from the steaming out of the solvent from the drained sludge, prior to dumping from the machine. This approximates a ton of effluent for every ton of sludge handled. The only way found by the writer to effect deodorization of this effluent and to render it harmless is by the addition of chlorinated lime or chlorine water. The greatest amount necessary for deodorizing very foul water is one part of 35% available chlorine bleaching powder to 3000 parts effluent. The noncondensible gases leaving the storage-tank vents must be scrubbed with chlorinated-lime solution before being allowed to pass to the atmosphere.

With these precautions it is safe to say that the entire operation of desiccation and degreasing, or the whole recovery operation, can be carried out with no offense.

In handling sewage sludge by this method, no difficulties have arisen other than those usually met with in handling wet organic materials of other sorts, and since in sludge, the moisture is present in free condition, mechanically combined, the period required for desiccation is much shorter than that met with in the treatment of garbage and animal refuse, in which the larger part of the water is more or less chemically combined. For this reason only four or five hours are required for drying a given amount of sludge, compared with at least twice that for the same amount of garbage.

Trial runs indicate the capacity of each tank as eight tons in 24 hours and that for a plant handling the sludge from a town of 200,000 inhabitants (approximately 40 tons 75% moisture basis daily) the cost for handling, including overhead and fixed charges, will approach $6 to $6.50 per ton on green sludge. This cost would not be greatly changed in handling sludge containing 75% or 50% moisture, but since the gross tonnage to be handled would be greatly reduced, the plant investment would be much less and therefore the byproduct returns per green ton much greater. If by any method of dewatering on beds, or other inexpensive method, the moisture can be reduced below 75%, by just so much will the success of a recovery plant pass from just self-maintenance to a possible profit.

Yield of Grease and Tankage

After carrying out such an operation, what possible yield of byproducts may be expected, and what is their character and what their value? This depends entirely on the nature of the sewage handled. It has been presupposed that any sludge running less than 3% of ammonia on a dry-tankage basis is not worth handling—unless, indeed, the grease content is very high, in which case it is possible that the grease alone might pay for recovery. From an average of a number of analyses, however, it would seem that a sludge low in ammonia is also low in grease, so that a 3% ammonia tankage would indicate a 15-25% grease content on a dry basis. For these reasons, in handling a 75% moisture sludge a yield of 430 lb. of tankage and 75 lb. of grease may be expected.

What is the nature of this grease and tankage; have they any market value? What use to rescue this material if it cannot be sold or used? This is not a matter to be dismissed off-hand. At the present time, if either or both of these products were thrown on the market, emphatically they would not find a purchaser, or certainly the price would be absurdly low. Consider

the nature of these byproducts as indicated by their analyses:

ANALYSES OF GREASES FROM DIFFERENT TYPES OF SLUDGE

	Free Fatty Acid, Per Cent.	Nonsaponifiable, Per Cent.	Neutral, Per Cent.	Moisture Per Cent
Baltimore (acidulated)	77.48	11.78	.....	10.74
Chicago (activated)	48.80	24.40	19.1	7.70
Syracuse (sedimentation)	51.50	19.30	18.70	10.50
Pleasantville, N. Y. (sed.)	75.70	19.80	4.50	.....
Boston Moon Island (sedimentation):				
	Per Cent.			
Free fatty acid (as oleic)	48.40			
Free fatty acid (by weight)	40.19			
Rosin acids (in fatty acid)	14.36			
Fatty acids (by difference)	25.83			
Unsaponifiable	21.09			
Neutral grease (by weight)	20.00	(molecular weight of neutral fatty acids 272)		
Metallic soaps and solid impurities	3.30			

The first four analyses are of grease recovered in the process outlined, and it will be noticed that, in the first three, large quantities of solid impurities and moisture are recorded. All grease of sewage-sludge origin on leaving stills contains large amounts of such impurities, since, due to the emulsifying action of the waxes present in the so-called unsaponifiable, it is very difficult to obtain clean greases without subsequent washing with acid and settling. The fourth analysis is of a grease after such treatment.

Saponifiable and Unsaponifiable Matter

These analyses are of several different types of sludge and sewage treatment, yet all present the following general characteristics:

The saponifiable matter in each case consists for the most part of free fatty acids and a very small portion of neutral grease or combined glycerides. This is, of course, anticipated by the fact that the greater part of the grease present in sewage sludge comes from hydrolyzed soap solutions, or through the action of bacteria and ferments neutral grease has been broken down into fatty acids and glycerine. In any event, the neutral grease present gives no hope of glycerine recovery, so at once the so-called grease falls into the grade of poor-class fatty-acid stock. Of the total fatty acids present, varying in a number of analyses, from 1% to 15% of the total consists of rosin acids. These again are from the soap solutions.

The unsaponifiable matter varies between 10% and 30%, but a majority of samples analyzed show an average of 20%. As may be supposed, the lowest percentages are found in strictly domestic sewages, where they are traceable to body waxes and products of physiological action. In mixed sewage from manufacturing towns the unsaponifiable is highest, as it is made up of mineral oils, thrown out from different factories, mills, etc.

Small percentages of metallic soaps of calcium, iron, aluminum and magnesium are present, but upon proper treatment are broken down into fatty acids and mineral salts, washed out as sulphates or chlorides, dependent on the sort of acid used for refining.

From these premises it is necessary to conclude that sewage grease can be regarded only as a very low-grade fatty-acid stock containing 70-75% of fatty acids and 25-30% of unsaponifiable matter. These fatty acids, depending on the sewage from which they are extracted, will vary in color from a dark ruby red to a black tarry-looking mass. In consistency the variation is between a soft, buttery mass and a hard and solid cake. This is quite readily explained; the former is very high in fluid-mineral and industrial-refuse oils, the latter, from domestic sewage in which the high-melting-point fatty acids have been hydrolyzed and precipitated from the soap liquors, whereas the oleic-acid soaps or oleic acid present in mixed soaps remain in solution and pass off with the effluent.

Fatty acids of this type have no legitimate market at this time. Such materials are only valuable as they are refined and made into marketable products. A purchaser of sewage grease would expect by his own efforts to give it all of the value it might ultimately have and, having created something out of nothing, would care to pay little for the raw material. That sewage grease in refined or manufactured form has value is not to be questioned. Such a grease as that indicated in analyses of the Pleasantville sludge grease, upon distillation in the manner usually employed for fatty acids, gave the following percentage yields:

Light colored distillate	85
Still returns	6
Stearine pitch	6
Loss	3

The distillate was orange yellow in color and of high titre, and upon pressing gave 50% of good-colored stearic acid of titre 53.3° C., and 50% of red oil containing 38.25% unsaponifiable matter. Upon pressing, all unsaponifiable matter passes out of seeded or crystalline cake in the red oil, leaving good stearic acid behind. This red oil is marketable for grease compounding and as wool oil. In other words, sewage grease must be manufactured to have value. Once its value is established, a market will be automatically created for the raw grease.

Who Shall Bear the Unavoidable Burden?

Upon whom shall the burden of carrying out these operations fall? Shall each sewage plant carry out the whole work from sewage to finished product? Shall a number of sewage plants pool their sludge, or their raw grease and tankage, and finish at a central plant, or shall a number of plants interest directly a corporation or individual able to carry out the refining operation? At this point sewage sludge ceases to be a problem for the scientist and becomes a purely business proposition.

Returning to the question of disposition of the tankage, it would require considerable propaganda to place upon the fertilizer-goods market a low-grade 3% ammoniate, cursed with the name sewage sludge, though in the old days of poudrette and natural guano it had an enhanced value in the public mind far greater than its chemical value indicated. The great diluent of sewage tankage is insoluble ash or mineral matter, running from 40-70%, with 60% as an average. It is not impossible to concentrate this, though methods are not yet complete for doing so. A number of experiments conducted by the University of California indicate that, for percentage of nitrogen contained, degreased sludge has a higher plant food value than dried blood or high-grade tankage.

Even with reasonable markets for the tankage and grease, it is a question whether it is possible to recover enough materials to defray the cost of the operation. In the opinion of the writer, and from experience in the garbage-reduction business, it does not seem impossible, though there would be little margin of profit left. But the sludge would be disposed of, its disposition paid for and a large amount of needed materials returned to active use to assist in helping out the world's supply

of chemicals and greases. The individual city would receive no monetary return, probably, but virtually to create actual, concrete products of economic value, to pay for the creation and at the same time solve a troublesome disposal problem, is something worthy of consideration.

With ordinary sedimentation of suspended solids, it is not at all unreasonable to expect from the sewage of a town of 150,000 persons daily recoveries of five tons of tankage and one ton of grease. There are many towns of this size. Any city of this class which can return to a useful cycle $50,000 worth of needed materials annually should consider well the disposition of its sludge pile.

Solving the problem of sludge disposal is not impossible, but it is difficult. No chemist, engineer, business man or politician can solve it alone. A coöperation which has not heretofore existed must be brought about before there can be any hope of solution.

Present Status of the Ohio River Improvement

IN 1908 the Federal Government, through the United States Engineer Department, began the construction of locks and movable dams on the Ohio River from Pittsburgh to its mouth at Cairo, by means of which a 9-ft. stage of water would be guaranteed. Work has been

GENERAL VIEW DURING CONSTRUCTION OF ONE OF THE OHIO RIVER LOCKS AND DAMS (NO. 33, NEAR MAYSVILLE, KY.)

steadily carried on during the past 11 years, though the total cost will be greatly in excess of the $64,000,000 estimated then for the 54 locks and dams. The accompanying table shows the state of the improvement at the end of the working season of 1919:

STATUS OF WORK ON SLACKWATER IMPROVEMENT OF THE OHIO RIVER, OCT. 1, 1919

Dam No.	Miles Below Pittsburgh	LOCATION With reference to nearest town or other geographical division
		Locks and Dams in Operation
1	4.7	West Bellevue, Penn.
2	9.0	Coraopolis, Penn.
3	10.9	Glenosborne, Penn.
4	18.6	Legionville, Penn.
5	23.9	Freedom, Penn.
6	28.8	Beaver, Penn.
7	36.9	Midland, Penn.
8	46.1	Newell, W. Va.
9	55.6	New Cumberland, W. Va.
10	65.7	Steubenville, Ohio.
11	76.3	2.3 miles below Wellsburgh, W. Va.
12	87.0	2 miles above Wheeling, W. Va.
13	95.6	McMechen, W. Va.
14	113.8	Woodland, W. Va.
15	128.9	New Martinsville, W. Va.
16	146.4	Ben's Run, W. Va.
17	167.4	4 miles above Marietta, Ohio.
18	179.3	4½ miles above Parkersburg, W. Va.
19	191.4	Little Hocking, Ohio.
20	201.7	Belleville, W. Va.
21	213.8	Portland, Ohio.
22	220.1	Ravenswood, W. Va.
24	242.0	Graham, W. Va.
26	278.0	Hogsett, W. Va., 9½ miles below Gallipolis, Ohio.
28	310.9	Huntington, W. Va.
29	319.4	3 miles below Catlettsburg, Ky.
35	449.7	1 mile below New Richmond, Ohio.
37	481.3	Fernbank, Ohio.
41	604.0	Louisville, Ky. (Old lock and canal in operation; canal widened; work in progress on construction of new lock, etc.)
		Locks and Dams Under Construction
23	230.6	Millwood, W. Va.
25	260.0	5 miles above Pt. Pleasant, W. Va.
27	300.3	4 miles above Guyandotte, W. Va.
30	338.9	3 miles below Greenup, Ky.
31	358.4	3 miles below Portsmouth, Ohio.
32	381.7	1 mile above Rome, Ohio.
33	404.0	3 miles above Maysville, Ky.
34	432.8	Chilo, Ohio.
36	458.4	10 miles above Cincinnati, Ohio.
38	501.3	Maxville, Ky.
39	529.6	1 mile above Markland, Ind.
43	630.2	3 miles below West Point, Ky.
44	660.3	Leavenworth, Ind.
45	699.7	Addison, Ky.
48	804.1	6 miles below Henderson, Ky.
		Locks and Dams Upon Which Construction Has Not Yet Been Commenced
40	553.6	2 miles above Madison, Ind.
42		Eliminated.
46	748.5	Between Rockport, Ind. and Owensboro, Ky.
47	771.3	1½ miles above Newburg, Ind.
49	830.5	7½ miles below Mt. Vernon, Ind.
50	859.6	Caseyville, Ky.
51	878.0	1½ miles above Elizabethtown, Ill.
52	913.2	1½ miles below mouth of Cumberland River.
53	946.0	Head of Grand Chain.
54	962.4	Mound City, Ill.

RECAPITULATION

Locks and dams completed and in operation	29
Locks and dams under construction	15
Locks and dams upon which construction has not yet been commenced	9
Locks and dams eliminated	1
Total	54

Concrete Mast 164 Feet High Built in Place

TWO wireless masts of reinforced concrete, each 164 ft. high, are to be built for the American Navy on the city wall at Pekin, China, according to an article in *Ingeniören* of Aug. 2, 1919. One of these masts has already been completed, and the other is under way. The contract was let by the Navy to the firm of Andersen, Meyer & Co., Ltd., Shanghai. For the first mast the original program contemplated precasting in two parts. This was done, but while the two parts were being lifted into vertical position the tackle broke, or some other similar accident occurred, and the mast fell, killing the European engineer in charge and four coolies. It was then decided to build the mast in place from a timber scaffolding. It is stated that this method proved very costly, and difficulties were experienced in constructing a scaffolding sufficiently rigid to support the concrete while setting. The work was carried out, however, to a successful conclusion. The mast is of hollow reinforced concrete, 16¾ in. in outside diameter, with a 4-in. wall at the base, and 12 in. in diameter, with 3½-in. walls at the top. A 1:2:3 concrete was used, with ¾ x ⅝-in. rectangular corrugated bars as reinforcement. The number of rods was not given in the article. The mast is guyed by four guy ropes, three of which go to the wall itself and the fourth to the ground inside the wall. The mast was designed with a factor of safety of 4 when carrying 11 ice-laden wires and exposed to a strong gale.

Engineers Teach Doctrine of Designed Roads

Systematic Instruction Converts Iowa to Active Support of Engineering Direction of Road Construction Work

ONLY road work designed and directed by engineers is done in Iowa. This practice applies to the whole 104,084 miles of state roads. The change to this condition from haphazard, untechnical local direction has been brought about by a campaign of education planned and conducted by engineers. Direct instruction by object lesson and by personal appeal aided by intelligent publicity were the methods.

The population of Iowa is largely rural, and when, in 1904, commission direction was inaugurated it was a population uninstructed in the nature or the cost or the value of modern, improved highways. It was also a population jealous of the right of local initiative in all affairs relating to public roads. Standards of road service were everywhere about the same and were generally low. Nowhere was the necessity felt to be keen for any radical change in road policies and practices. County and township control was intrenched, and centralized state control had only scattered support.

In 1904, therefore when a state highway commission was reluctantly created, it was made a commission without authority. No salaries were paid. No money was given to it to expend for road construction or maintenance. The fund allowed it for expenses was negligible. It had only advisory powers. Communities need not ask its advice and, if they did, were not required to follow the advice. But because the deans of the two state engineering schools were named as commissioners it was in spirit an engineering commission and possessed the outlook of engineers toward a future road construction program.

Earth Roads First Considered

Under the conditions, the first requirement of any plan was guaranteed earth-road service. Agitation for paved roads was certain to fail. No community would have countenanced the expenditure, and the communities held the purse strings and the sole right to plan expenditures. To build up a permanent road system was the object, but, during the operation, continuous and general earth-road service must be maintained. This service being assured, it followed that, so far as practicable, all construction ought to contribute to the accomplishment of the ultimate permanent road system. A working policy was adopted based on the reasoning outlined.

Hard surfacing could not be contemplated. Permanent culverts and bridges could, however, be urged, and the arguments would have a receptive audience, because it was an audience which had been badly cheated in the quality of the structures it had been getting. Standard culvert and bridge plans and specifications were prepared. Engineering advice was gratis to those who asked it, and a planned effort was made to create a public sentiment favoring permanent structures. These activities were extended with time, and as more money was granted to the commission for operation. In a few years, counties were voluntarily building commission-designed or approved bridges and culverts in quantities.

The greater measure of success of the commission bridge and culvert activities was the educated public sentiment, and not the totals of structures built. The road-using public was being trained by object lessons into the habit of permanent road construction and to a knowledge of the value of engineering direction of road work. The growth of this sentiment was capitalized year after year in increased appropriations from the legislature. Finally, in 1913 it was capitalized in a broad way. A basic road law was secured, the effect of which was to place engineering paramount in highway development.

Commission Law Gave Authority to Commission

By the new law no money was given to the commission to spend in building roads. Initiation of road improvements still remained with the community. However, the commission was made responsible for all plans for permanent work, and compliance with these plans by the community was made obligatory. Thus, no permanent road work could be planned except under the technical supervision of the engineers of the commission. The law also required that the county supervisors employ county engineers to have technical direction of road work, and provided that the highway commission could remove these engineers for incompetence. The road mileage was divided into county roads and township roads. The powers of the county supervisors and township trustees were defined. A financial accounting to the commission of all road expenditures was required. Means for raising road funds were provided, and the allotment and disposition of these funds were stipulated. The methods of road maintenance and the organization for directing it were specified.

Centralized engineering direction of road work was definitely established by the basic road law of 1913. By the creation of county engineers, a permanent, state-wide machine for exercising this centralized direction was provided. This development from uncorrelated, untechnical, local administration of road work was the educational accomplishment of the commission engineers in nine years, from 1904 to 1913. It was not the final step. The welding of the commission and the county engineering units into an organization having a common purpose remained necessary, and further enabling legislation was desirable.

Qualifications of County Engineers Raised

County engineers, by the law, are employed and compensated by the counties. They can be removed by the highway commission for incompetence, and they must design to the commission's standards. Where a contract exceeds $2000 they must have the commission's approval. Success of the commission's road policies therefore depended very largely upon the qualifications and the coöperation of the county engineers. Adequate compensation and the surety of continuing in the office were essential, if qualified and reliable men were to be secured. By advice and admonition, and occasionally by exercising its power to discharge, the commission gradually raised the standards in both respects. Salaries now range from $2000 to $3000 a year. About 90% of the men are graduates of engineering colleges. Most of them are continued in office year after year. The result is a body of engineers of high efficiency, imbued with the policies of the commission and familiar with its precedure, and, as citizens, interested in having the community obtain good structures.

Education of the people to higher standards of contracting proceeded hand in hand with their education to higher standards of engineering. The counties generally were being cheated in a large portion of their contract work. To demonstrate this, an object lesson was again employed. The commission engineers went into certain counties and dug up structure after structure and showed where work paid for had never been done. The lesson was sufficient. With the placing of contract construction strictly on an engineering basis, contractors began to play the game squarely, and other contractors who had kept out of county road work because of its undesirable character began to solicit work. This movement was encouraged by the policy of the commission—reflected by the county engineers—of watching out for the contractor's interests. The attitude was that the engineer was just as much concerned in seeing that the contractor made a legitimate profit as that he did good work. Today, as the result, Iowa boasts of having a body of road contractors as reliable as can be found in any branch of construction.

Additional Powers Needed by Commission and Obtained

As the law of 1913 was enforced, the need for additional powers became evident. For example, in many instances road drainage was not possible because the surrounding country was not drained and there were no outlets. A law was urged and obtained which enabled county engineers to establish drainage districts, build the necessary works, and assess the cost on the benefited property. In the same manner, power was obtained to condemn property for roads or for supplies of road materials and to improve dangerous crossings of railroads at grade. Nearly a score of these supplementary laws were obtained. Finally, the primary road law of 1919 was enacted, centralized technical direction of road construction was clinched, and money and methods were provided for building an intercounty, or state, system of paved roads.

The revolution in public sentiment from indifference and incredulity to active belief in complete engineering administration and to hearty support of a plan to hard-surface 6300 miles of main road was accomplished by continuous and persistent educational work. Two methods principally were employed. Publication monthly of a service bulletin; personal instruction assisted by object lessons.

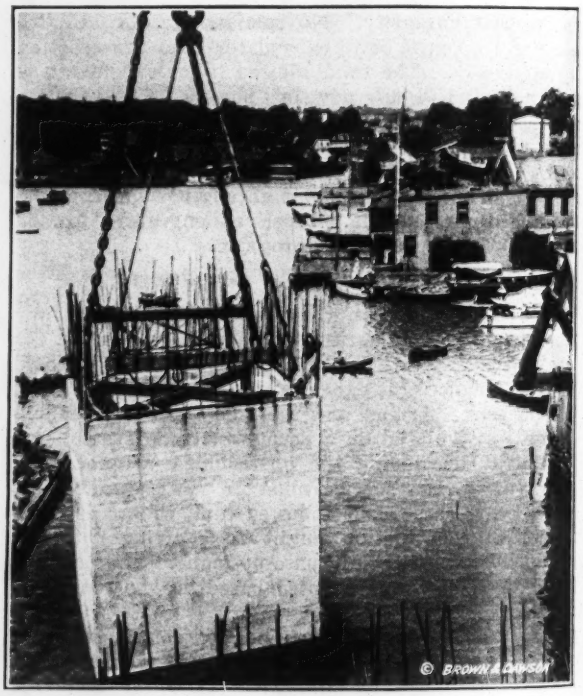
Publish Service Bulletin

Publication of a service bulletin was begun in 1914 and has been continuous to date. It has been mailed regularly to all road officials, newspapers, members of the legislature, and citizens having influence in public-works affairs. This bulletin does not deal in glittering generalities or in word pictures. It tells what the commission and the various counties were doing, and it gives the results in terms of cost and service. It presents examples of bad practice as well as of good practice, and evaluates in dollars and cents the losses resulting from bad practice. It publishes articles, by county and commission engineers, giving methods and costs of work, and explaining the economic reasons for the designs adopted. It keeps close to the facts that are of direct interest to the officials directing road work and to the practical business men and farmers who are paying for road work. With the continuous publication of the service bulletin, other means of publicity have not been neglected. Newspaper articles, pamphlets, broadsides and posters are employed. Demonstrations are staked on occasion, road schools are held and exhibits made.

Personal influence was adopted as the main lever for moving public opinion. The engineers of the commission and of the 99 counties of the state, who had been amalgamated into a body with the same connections and trained in the same methods, provided the teaching staff. Swivel-chair instruction was discouraged; the men were expected to go into the field. As an illustration, in 1917 the commissioners and the men from the main office were in the field an aggregate of 255 days, and the five district engineers were in the field an aggregate of 1169 days. Every county engineer every working day was in touch with some portion of his territory.

Precast Concrete Pump Well Set in 12 Feet of Water

TO HANDLE the condensing water in the generating plant of the Stamford, Conn., Gas & Electric Co., on Long Island Sound, three 20-in. centrifugal pumps are located at the bottom of a 25-ft. well structure in water 12 ft. deep at low water with a range of



LOWERING 150-TON CONCRETE PUMP WELL INTO SOUND AT STAMFORD, CONN.

tide of 13 ft. This well structure is made up of two precast reinforced-concrete boxes, each 30 x 21 ft. in plan and 25 ft. high, which were cast on shore, and lowered into place with a heavy wrecking derrick as shown in the view, onto a foundation leveled and prepared by divers.

Each well has walls 12 in. thick and a bottom 18 in. thick, with an interior 14-in. cross-wall which separates the screen chamber from the pump well proper.

Effect of Size of Lots on Cost of Industrial Housing

A Study of Yard Frontages and Depths in Relation to Outlays for Utilities, Streets and Sidewalks — Possible Economies

By Morris Knowles
Consulting Engineer, Pittsburgh, Penn.

MEASURED in terms of utilities and street improvements, the addition of depth to house lots entails much less cost per foot than the addition of width, according to studies of an assumed example of an industrial town. The data, from which the following has been abstracted, will appear in a forthcoming book.

Those portions of utilities and street improvements which directly relate to size of lots are:

1. Street improvements and utilities located directly in front of the space lying between houses.

2. Street improvements and utilities located on minor streets that lie parallel to space occupied by front yards and by rear yards.

3. Lengths of house service connections which are located in front yards and in rear yards.

Assumed Industrial Town Site

In order to obtain relative costs, it will be necessary to assume an industrial town. Following are the factors: An industrial town with 1000 houses. Houses are 22 ft. wide and 30 ft. deep; lots are 42 ft. front by 80 ft. deep. Houses are located on center line of lots and are placed 15 ft. back from front property line. Main streets are 50 ft. wide, minor streets 40 ft. wide. Main streets have 24-ft. paved roadway, 5½-ft. planting strips, combined concrete gutters and curbs, and 5-ft. sidewalks. Alleys are omitted. There are 24 houses in each block, making length of block 504 ft. and width 160 ft. There are approximately 42 such blocks in the town site.

It will be noted that the house is 64% of total cost, including distribution of overhead; the land, with lot improvements, 12.1%; street improvements, 9.9%; water, electrical, gas and sewer improvements, with house connections, 14%. Engineering, supervision and interest charges, which are distributed in these statements, are 14.24% of the whole.

Table II shows that if the space between houses on main streets is increased 1 ft. the cost of utilities and street improvements per house is increased $14.53. If the front or rear yard is increased 1 ft. in depth, the cost of street improvements and utilities per house is increased $2.48. These computations bring out the interesting fact that in so far as street improvements and utilities are concerned 5.86 ft. can be added to the depth of the front or the rear yard for the same cost as adding 1 ft. to the width of the side yard.

Assuming for sake of comparison a lot 42 ft. front by 80 ft. deep, the combined cost of land and lot improvements is equal to $568.64, or $13.54 per front foot. (See Table I.) If, for this lot, the costs of main and minor street improvements and utilities are combined and quoted as cost per lineal front foot of side yard parallel to yard space, they equal $20.73 per lineal foot.

If the cost of the land and lot improvements be combined with the cost of utilities and street improvements on the main street parallel to the side yard, the cost per lineal front foot of the side yard is $28.07. Assuming rents are based on 10% return, rent for each front foot of side yard is 23c. per month.

While no sweeping conclusions can be made, because we have discussed only one assumed industrial town site, it is interesting to note that the cost per lot for "street improvements and utilities" is $1121.93, compared with $568.64 for "land and lot improvements," the latter being 50% of the former. If, however, we compare the cost per front foot of those elements of street improvements and utilities directly related to the size of lot with the cost per front foot of lot improvements and land, they are respectively $20.73 and $13.54, the latter being 65% of the former.

TABLE I. ESTIMATE FOR ASSUMED TOWN SITE

Item	Cost per House	Per Cent of Total Cost	Per Cent, Including Overhead
1. House	$3,000 00	54 85%	64 0
2. Land	336 00	6 14	7 2
3. Lot improvements	232 64	4 25	4 9
4. Street improvements	463 29	8 48	9 9
5. Water system	190 15	3 48	4 1
6. Electrical system	26 33	0 48	0 6
7. Gas system	101 18	1 85	2 1
8. Sewers—storm and sanitary	202 48	3 70	4 3
9. House connections	138 50	2 53	2 9
	$4,690 57		
10. Engineering and supervision at 10%	469 06	8 58	
	$5,159 63		
11. Interest, at 6%	309 58	5 66	
	$5,469 21	100 00%	100%

TABLE II. COST OF UTILITIES AND STREET IMPROVEMENTS PARALLEL TO YARD SPACE

Parts of Items	Cost for Length Parallel to 20-Ft. Side Yard	Cost per Lineal Front Foot of Side Yard	Cost for Length Parallel to 50-Ft. Front and Rear Yard	Cost per Lineal Foot Depth of Front and Rear Yard
4. Street improvements	$178 60	$8 93	$55 00	$1 10
5. Water system	36 40	1 82	13 00	26
6. Electrical system	4 20	21	00	00
7. Gas system	17 40	87	6 50	13
8. Sewers—storm and sanitary	54 00	2 70	17 00	34
9. House connections	00	00	32 50	65
	$290 60	$14 53	124.00	$2 48

Condensed suggestions on economical design and construction follow: Use of contour streets; grading of lots and streets at same time; design of street widths and pavements to meet demands of traffic; comparison of cost of reducing grade with cost of a pavement suitable for steeper grades; making of sidewalks not unnecessarily wide; use of combined gutter and curb; study of relative merits of alleys and easements; careful study of location of utilities; use of combined trenches where suitable; substitution of direct sewer connections for catchbasins; use of combination manholes; connection of roof leaders to gutters; omission of storm sewers near summits of streets; installation of house connections at one time; carrying of house wire services on brackets attached to rear of house; and so forth.

Mexican Railroads Suffer Heavily by Storms

According to a recent issue of *Commerce Reports*, extensive and immediate appropriations of public funds are necessary to repair damage done to Mexican national railroads by recent storms. More than 50 bridges, large and small, were destroyed in the division from Jimenez to Chihuahua. It is stated that the large Otiz bridge, in the State of Chihuahua, will have to be rebuilt completely. It is planned to construct a new bridge entirely of concrete, in order that it may more successfully resist repeated overflows of the River Concha.

Meters Cut Water Consumption of City In Irrigated District

By C. E. Painter
With Tibbets & Pleasant, Contractors, Okmulgee, Okla.

When the officials of Twin Falls, Idaho, were shown that there was a daily per capita consumption of 450 gal. and that payment was being received for only 20% of the water delivered, metering was speedily adopted. The writer, when employed recently as resident engineer for the construction of a purification plant, by Burns & McDonnell, consulting engineers, Kansas City, Mo., investigated the meter situation and found 1800 taps, 38 meters, 10,000 population and 4,500,000 gal. of water used. Knowledge of conditions and publicity brought about a more equitable relation between the water-works department and the consumers, for within three weeks after the report was presented 500 meters were ordered and a price contract was made for future orders. Twin Falls will shortly be 100% metered.

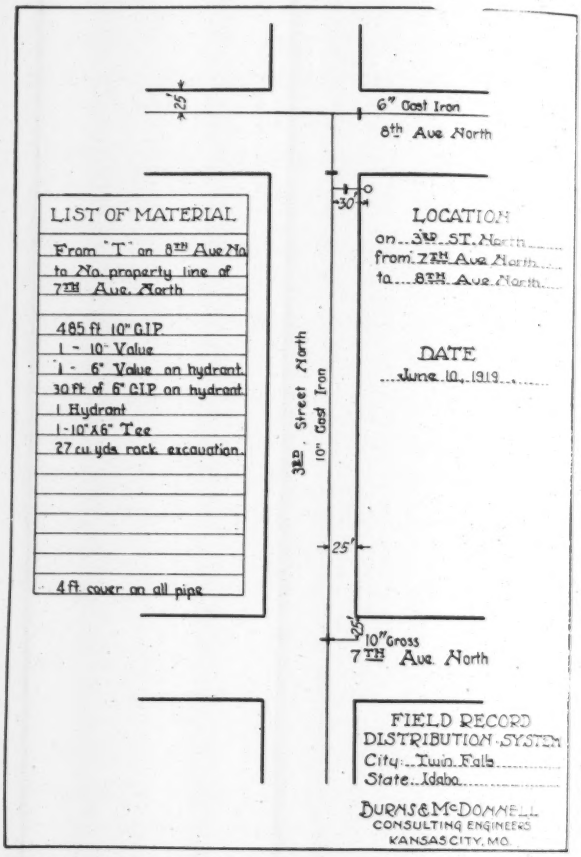
It was rather startling to find that the total income—fire hydrants and sewer flushing included—when estimated according to existing meter rates, indicated that the city received payment for only about 20% of the water that left the plant. In these circumstances the plant could not be expected to take care of itself financially. The estimated operating costs are $52,000 and the receipts last year were $4000 less.

Leaky plumbing was found to be responsible for the largest loss. Definite figures as to the more equitable basis of charge produced by the installation of the first 24 meters are given below:

	Flat Rate	Aver. Yearly meter rate
Twin Falls Steam Laundry	$ 11.50	$ 25.09
Western Auto Co.	5.00	2.74
H. E. Cutting	2.00	1.41
Twin Falls Auto Co.	5.00	6.72
Johnson Auto Co.	5.00	2.61
George Batley	8.00	6.64
Twin Falls Auto Co.	5.00	5.43
Rice Building	2.50	3.54
Young Hardware Co.	2.00	1.13
Gooding Motor Co.	5.00	2.57
Perrine Hotel	40.00	66.20
Seal Auto Co.	5.00	4.93
Lee Woodcock Barn	2.50	2.11
Troy Laundry	20.00	27.10
Twin Falls Livery Barn	2.50	1.06
Idaho Auto & Supply Co.	5.00	3.73
J. F. Blankenship Barn	2.50	2.86
Belleville Bros.	5.00	1.06
Nick Smith	2.50	2.55
C. A. McMaster	2.50	7.42
J. A. Johnson	2.50	3.71
A. M. Sande	5.00	24.15
Lincoln Produce Co.	15.00	68.85
Sterling Creamery	35.00	30.27
	$196.00	$303.88

Of these 24 customers 50% were being overcharged, and to the other half water was being presented free of charge. This was not equitable. The total income was increased incidentally 55%, and much water was saved. A typical individual example of what happened is the Twin Falls livery barn. For the first two months after the meter was installed the use was 2878 and 2001 cu.ft., with charges of $5.30 and $4.00, respectively. Repairs were made, and for the next two months the use was 396 and 402 cu.ft., with minimum charges of $1 each month. The former flat rate was $2.50 per month. In the case of the Perrine Hotel, where the rate increased 65%, the plumbing was not repaired, the owner apparently feeling it was cheaper to pay water bills than plumbing bills, but the city receives pay for water delivered.

Another point made in the report was that the present purification plant would have to be extended within five years if the consumption were not curtailed. Between 11 a.m. and 1 p.m. and from 5 to 7 p.m. water was used at the rate of 7,000,000 gal. daily. By running over capacity for a few hours the plant can care for this rate, but only for a limited period. If restriction is made to legitimate use, the present capacity of the plant should be good for 15 to 20 years. It was recommended that the city buy 500 meters and require the customer to deposit $15 to cover cost of meter and installation, then to finance the next and succeeding purchases from the fund created by the deposits.



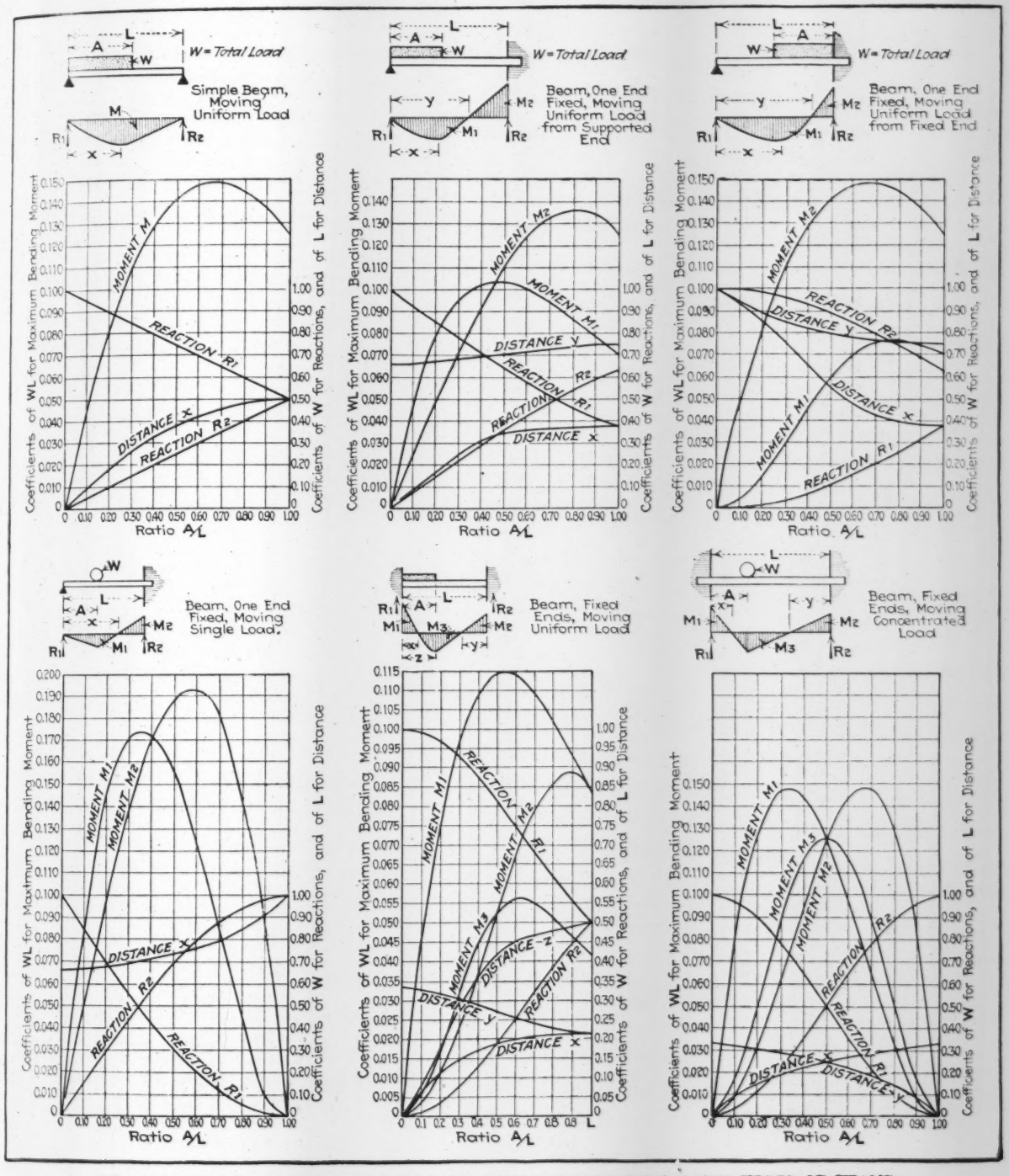
WATER DISTRIBUTION SYSTEM RECORD, TWIN FALLS

Diagrams for Reactions and Bending Moments of Beams

By Raymond Burnham
Consulting and Designing Engineer, Chicago, Ill.

The six diagrams herewith have been of great value in facilitating the calculation of beams under unusual loading, or for moving loads. They can be used to obtain the maximum bending moments, the reactions, the points of contraflexure and the points of maximum bending moment. The diagrams include the simple beam with moving uniform load, beams supported at one end and fixed at the other for moving uniform loads or concentrated loads, and beams fixed at both ends for moving uniform or concentrated loads.

The method of using the diagrams is quite simple. For example, take the case of a beam supported at one end and fixed at the other with a uniform load


W = Total Load
Simple Beam, Moving Uniform Load
Beam, One End Fixed, Moving Uniform Load from Supported End
Beam, One End Fixed, Moving Uniform Load from Fixed End
Beam, One End Fixed, Moving Single Load
Beam, Fixed Ends, Moving Uniform Load
Beam, Fixed Ends, Moving Concentrated Load
MOMENT M
MOMENT M1
MOMENT M2
MOMENT M3
REACTION R1
REACTION R2
DISTANCE x
DISTANCE y
DISTANCE z
Coefficients of WL for Maximum Bending Moment
Coefficients of W for Reactions, and of L for Distance
Ratio A/L

REACTIONS AND BENDING MOMENTS FOR MOVING LOADS ON VARIOUS TYPES OF BEAMS

coming on from the supported end. The diagram for this case gives the negative moment equal to the positive moment when the load covers 0.46 of the length of the beam, at which time the reactions are two-thirds and one-third of the load, respectively, and the distance to the point of contraflexure is 0.7 *L* from the supported end, while the point of maximum moment is 0.33 *L* from the supported end. This diagram also shows that for a fully loaded beam, the negative bending moment is 0.125 *WL*, and the positive bending moment is 0.7 *WL*; the reactions are 0.625 *W* and 0.375 *W*. The distance to the point of contraflexure is $\frac{3}{4}$ *L* and the distance to point of maximum moment is 0.38 *L*. These results accord with the ordinary formulas for a uniformly loaded beam supported at one end and fixed at the other.

The other diagrams are used in precisely similar manner, all bending moments being given in turns of *WL* and reactions in terms of *W*, the total superimposed load.

Heavy Rain Destroys Sewer and Railway at St. Louis

City Delayed Taking Engineer's Advice After Earlier Damage — About 4 Inches of Rain in 2½ Hours

By W. W. Horner
Chief Engineer, Sewers and Paving, St. Louis, Mo.

An unusually heavy rainfall at St. Louis, Mo., on the evening of Sept. 28, destroyed about 250 ft. of the Rocky Branch sewer, and washed out a number of railroad tracks beneath which the wrecked sewer passed. The downpour lasted about 2½ hours, during which time from 3.3 to 4.1 in. of rain was registered on gages at various points in the city.

The rain was quite steady during a large portion of the time, but the maximum rates were not exceptional, the heaviest five minutes being 0.35, the maximum ten minutes being 0.7 and the maximum hour 2.35. The rain caused considerable damage throughout St. Louis, overcharging many of the sewers in the lower part of the city, and creating a flood of the River des Peres, which left its banks throughout almost its entire length.

The greatest actual damage to city structures was at the outlet of the Rocky Branch sewer. This portion of the sewer is of horseshoe section, constructed of brick and stone partly supported on piles. The section is approximately 14 ft. in height by 12 ft. in width and was built prior to 1870.

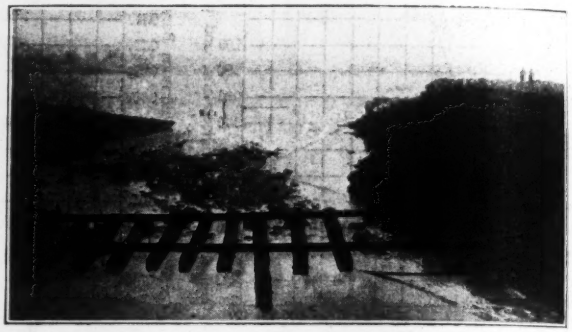
The original end of the sewer was carried away some time ago by undermining by the water flowing from the sewer itself. Since then large sections have been carried away from time to time, so that the sewer was probably 100 ft. or more short of its original outlet.

This matter was brought to the particular attention of the city officials two years ago, when the plans for the construction of the North Market St. municipal docks were taken up. The new docks were to be built immediately south of the sewer, and the line of the dock face was to be about 300 ft. farther out in the river than the end of the old sewer. A request for an appropriation to extend the sewer was made at that time, with an estimated cost of $30,000. Since then the dock has been constructed and a fill made along the south side of the sewer estuary, and also some additional length of sewer carried away. An appropriation of $50,000 for the extension was made in the summer of 1919, and the work of extending the sewer by the city's forces was started late in September.

SEWER OUTLET BEFORE RAIN OF SEPT. 28

Only a few piles on the site of the new outfall had been driven when the storm of Sept. 28 occurred. The sewer undoubtedly ran full, and under a considerable head. The erosive effect of the stream on the soft ground under the outfall progressively undermined the old piling and permitted the sewer structure to collapse in large units at a time. In all, about 250 ft. of the sewer was carried away, bringing the new outfall back to the edge of the main line Burlington tracks, which were temporarily abandoned, and washing out on the way four tracks of the St. Louis Transfer Railway, a part of the freight terminal systems.

The estimated cost of replacing the sewer destroyed by this rain will be about $40,000, in addition to the $50,000 which had been appropriated for the extension of the outlet. A temporary apron is being built under the outfall to prevent further undermining, but it is probable that another very heavy rain would destroy additional sewer and possibly begin to undermine buildings in the vicinity.



LOOKING TOWARD THE RIVER FROM THE BANK ABOVE THE SEWER OUTLET AS IT STOOD AFTER THE WASHOUT

Society Service

A Section Dealing with the Results of Teamwork by Technical Men

Providence Drive Nets 62 Per Cent Membership Increase

The Providence Engineering Society recently completed a 15-day membership drive which netted 370 new applications—more than 62% of the membership—and which will bring the society's total number of members to 966, a remarkable membership for an engineering society serving a city of less than 300,000 people and an industrial community of about 600,000. Credit for the achievement, according to a communication from Prof. James A. Hall of Brown University, is largely due to Frederick W. Bliss, chairman of the membership committee, who personally laid out the campaign and created a great deal of its enthusiasm.

Fifteen teams of five men each were chosen and each team was assigned five names of prospective members and the names of ten industrial concerns which were not represented in the society. During the first week those names were limited to the teams to which they were assigned, but throughout the remainder of the competition the field was open, and all competitors were urged to go after anyone whom they considered eligible. The result was most gratifying, as a large number of engineers not formerly connected with the society were

brought in, and in addition, many presidents and heads of business concerns have joined the society as associate members. The scoring was based on the size of entrance fees for the various grades of membership—that is, 4 points for senior or associate, 3 points for junior, and 1 point for student. In all cases the entrance fee must necessarily accompany the application. The points scored in securing the 370 new members totaled 1219.

Society Carries on a Publicity Contest

Publicity for engineers and engineering societies, in local newspapers, is being promoted throughout the country through a publicity contest being held by the American Association of Engineers. On Sept. 1 its chapters and clubs entered a contest of indefinite duration, to see which could obtain the greatest number of column inches of space, covering legitimate news, in their local newspapers. Up to the middle of October the Globe-Miami Chapter in Arizona led with 267 column inches. The St. Louis Chapter had 211 and the Portland, Ore., Chapter 176. Some of the other chapters stood as follows: Toledo, 64; Phoenix, 65; Parsons, Kan., 45; Washington, 42; Knoxville, Tenn., 33; Indianapolis, 31; Butte, Mont., 25; Chicago, 25; Dayton, 25; Baltimore, 25.

No attempt has been made to furnish "boiler plate" from national headquarters, all of the copy being furnished by local effort and with the main purpose of advising the public as to what the engineers were doing. Much of the publicity has consisted of society activity, although in St. Louis the copy has dealt largely with the efforts of the municipal section to obtain an increase in compensation.

In counting space, only items containing the word "engineer" are accepted. If it appears in the heading ¼-in. or more in height an extra 5 in. of space is allowed. Several items have been capped by eight-column heads some of which contained the word "engineer."

In the opinion of the society officials, the value of this publicity to the profession cannot be overestimated. Through reading the news items appearing in his local newspaper the average citizen will find out that there are many more engineers in his community than he ever realized; that this body of men is active in civic work; that it is working for legislation to protect the public interest; that it is insisting on the appointment of trained men to public offices supervisory over engineering works; that engineers have a code of ethics and are trying to improve it; and that the notorious high cost of living treats an engineer no less rigorously than the layman. In short, he will learn what engineers are doing and the value of the engineer's service to the community, and in time he may learn that the professional engineer does not drive a locomotive or tend the boilers in an office building.

LOWER OTAY DAM HIGHEST TYPE OF ENGINEERING ART

This Is Statement of Dr Nawell at Banquet Given in His Honor

Know YOUR Chicago
The American Association of Engineers

ENGINEERS WANT PUBLIC WORKS DEPARTMENT

Tidewater Chapter Saturday Night To Discuss Proposal

BOARD NAMED BY ENGINEERS TO AID FOSTER

Association Pledges Support to Anti-Leslie Candidate for Commissioner.

TELLS COUNTY NEEDS

ENGINEERS LEAVE CITY EMPLOY FOR BETTER SALARIES

Failure of Administration to Grant Request for Higher Wages Causes Technical Experts to Resign, Declares Kinzy.

DEPARTMENT TO BE SHORT FOR NEW BOND ISSUE WORK

Amendment to Be Suggested Providing $700,000 Allowance for Payment of Additional Engineers and Administration Expenses.

NOTED ENGINEER APPEALS TO MEN HERE

Says Association Something More Than Labor Union Move

ENGINEERS' CLUB SAID TO BE HOSTILE TO FREE BRIDGE

F. H. Gerhart Declares at Hearing on $22,000,000 Bond Issue That Railroads Control Body

SPEAKER ARGUES FOR EAST SIDE APPROACH

Opposition Voiced to Items for Improvement of River du Pere and Elimination of Grade Crossings.

AMERICAN ASSOCIATION OF ENGINEERS BANQUET

SOME RESULTS OF ENGINEERS' PUBLICITY CONTEST

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Engineering Fundamentals for Four-Year Course

Sir—I think perhaps it is worthy of note that the College of Applied Science, which is the Engineering College of the State University of Iowa, has taken what it thinks to be a step in advance toward the devotion of the four-year college course in engineering to the development of the fundamentals of the profession of engineering as distinguished from the development of specialists in one or another branch of engineering.

The College offers five distinct courses, namely, courses in civil engineering, mechanical engineering, electrical engineering, chemical engineering and chemistry. These are all four-year courses except the course in chemical engineering, which is a five-year course.

By action of the faculty last year, which action was put into effect this year for the first time, the first-year work in the four engineering courses is alike, and the civil, electrical, and mechanical courses differentiate only in the senior year, and then only to the extent of twenty of the thirty-four semester hours constituting the year's work.

All students in these courses receive the same instruction in the ordinary fundamentals of mathematics, chemistry, drawing, shop work, surveying, physics, descriptive geometry, mineralogy and geology, mechanics, materials of engineering, hydraulics, machine design, stresses in static structures, steam engine, the generation, transmission and delivery of electric power.

They also receive the same instruction in economics, accounting, business law, English and metallurgy.

In the senior year special work in surveying and railroad surveying, structural engineering, road engineering and sanitary engineering is given to civil-engineering students. Special work in the theory of electricity, electro-chemistry, telephone and telegraph, illumination, dynamo design and power-plant engineering is given to electrical engineering students. Special instruction in shop work, heat engines, engine design, heating and ventilating and power-plant design is given to mechanical engineering students.

We are hoping to take further forward steps later.

WILLIAM G. RAYMOND,
Dean, College of Applied Science, University of Iowa.
Iowa City.

What Will Engineers Pay To Improve Their Status?

Sir—I am in receipt of your favor inclosing copy of an editorial entitled "What Will Engineers Pay To Improve Their Status?"

In reply to the questions asked in this editorial, I can scarcely put the assurance strong enough that engineers will pay, and will pay willingly, to improve their status, when it is known that such expenditure is in capable hands and will be devoted to an achievement of the desired end in an efficient manner. The local association of the American Society of Civil Engineers has had a great deal of discussion among the members as to this question, and I believe it is a fact that many engineers had not taken the time to realize that their status needed improving until this discussion began. Through this section, at least, there has been a great realization of the part which the engineer is capable of playing in public and civic affairs. There is no doubt that with this awakened interest those affected will be willing to pay whatever is necessary in order that their effort toward improvement may be properly directed.

I rather hesitate to state the probable amount which could be raised among the engineers of Nebraska to further this movement, but I am sure that there would be a prompt and generous response to any reasonable request.

HOMER V. KNOUSE.
Omaha, Neb.

Sir—I did not read your editorial in the Sept. 11 issue on "What Will Engineers Pay To Improve Their Status?" for the reason that I did not receive that particular issue. For an ex-engineer like myself, the replies to the above question in the Oct. 16 issue, pp. 720-722, made extremely interesting reading. Through reading these replies I also gleaned the sense of your editorial. Interesting as was the reading of these replies, greater still was the disappointment with their sense and reason.

To be in accord with the idea and purpose of Engineering Council is the least one can do; to support it financially follows as a matter of duty to an accepted cause. However, if engineers—"that great body of junior engineers or noncommissioned officers" (F. H. Newell)—earn so little that they are compelled to ignore an obvious duty, they are more to be pitied than censured, but also more to be censured than admired.

F. H. Newell correctly presented the subject, or, rather, the plight of the engineers; but what does he propose as a remedy? "Greater public recognition of the engineer's worth"? To what end? To improve the engineer's status. How obviously inadequate! What does the public care about the engineer's status, when its elected and appointed officials, who are supposed to know better, are so indifferent to his status. Witness the recent action of the New York Public Service Commission, First District, in laying off hundreds of engineers with a half-hour's notice; the laying off, a few years ago, by the New York State Engineer, of hundreds of engineers for political reasons. The public marvels at the engineer's achievements (and it is the most patent objects only that elicit an admiring phrase) but does not restrain its unqualified condemnation of engineers at large, when an old dam breaks, or other large-scale accidents occur. The public never stops to ask the cause of the inadequacy of those structures that fail, for if it did it would learn how little is the engineer responsible, and how much is the business man behind the project responsible. The public at large is all too ignorant and stands in need of general enlightenment much more than the engineer needs the public's recognition of his worth.

It is disgraceful enough that a body of men so intelligent, upright and necessary to the country's progress should have cause to beg for recognition at all, let alone for the purpose of improving its status, and that from a body so indifferent as the public.

The existence of the ten thousand "senior engineers" estimated by Mr. Newell does not alter the situation, because their technical excellence is beyond the grasp of the public. In fact, their existence as an independent body, who "consider themselves, and doubtless are, the men of the profession" (F. H. Newell), is in a great measure responsible for the pecuniary plight of the estimated 100,000 junior engineers. The "best men" are mostly employers of engineers, and their tactics and ethics are those of the business world. They may wonder wherein this is derogatory to their standing as engineers, but the writer, now successfully prosecuting a very large business, can say, despite any one's contradiction, that business ethics and engineering ethics are as different as the ethics of Tammany Hall compared with those of the American Society of Civil Engineers.

Why not come down to fundamentals and recognize that the engineer's plight is caused by the economics of our industrial order; that to improve his status it is first necessary to change his status? Licensing and unionizing, however odious to some socially backward engineers, are the immediate remedies for his betterment. Necessity is driving engineers together, or apart. If they stick together, no matter how (except through the technical societies) they will eventually learn to seek licensing and unionizing, hence—why not now? If they are thrown apart, then as a rule, they leave the profession and seek improvement in their status through the medium of business. Usually they are successful. This fact has fast spread, with the result that the engineering ranks have been depleted. The loss to the community and country is incalculable. The wasted years of study, training and getting experience cry out in vain, for the public offers a deaf ear, the technical societies a dumb mouth, the "uplift" organization useless endeavor, in the face of a vicious and unjust social and economic order of society. Such

ancient minds as R. B. Shepard, Jr.'s., and Wendell M. Butts', may feel horrified at this frank truth, but A. L. Dabney and F. H. Newell and the many progressive engineers whom necessity has forced to think socially will agree with me that only a fundamental change in the engineer's status will bear fruit.

I am in favor of all technical societies, "mutual-aid" (engineers') societies, etc., but most of all of licensing and unionizing. J. Ross.

New York City.

Theory and Shelf-Angle Support for Girders

Sir—The writer wishes to take exception to some of the statements which were made by Edward Godfrey in his article on "Common Errors in Detailing Steelwork for Buildings," appearing in your issue of Oct. 16. These statements are potential sources of dangerous influences over inexperienced designers, especially so when made by an engineer of wide reputation.

Particular attention should be directed to the author's discussion of the manner of connecting a steel beam to a column shown in sketches (a) and (b) of his Fig. 1. Sketch (a) shows a beam resting upon a shelf angle of ample strength to carry the load, yet the beam is not attached rigidly to the side of column. Very rightly this is termed an eccentric load, the moment resulting being evident and determinate. Mr. Godfrey condemns this detail and favors that shown in sketch (b), where the beam is given a rigid and full-depth connection to the column side, stating that the fixed condition renders the beam and adjacent portion of column, in effect, a single unit capable of acting as beam to carry the load to the column axis. This is true only when the beam is unusually rigid in comparison with the column, a condition sometimes found where heavy beams are supported by relatively slender columns in upper stories. Elsewhere it is dangerously erroneous.

The author's arguments can be attacked by the most elementary and simple line of reasoning and with complete freedom from the least-work ideas of the "ultra-theorists" so emphatically scouted by Mr. Godfrey.

Any beam carrying a load is under stress and subjected to deflection, which results in its center being lower than the ends. The downward inclination from the ends toward the center must be considered. In the connection of sketch (a) there is a slight tipping upon the support, and the moment is as Mr. Godfrey states. In the detail of sketch (b) the rigid connection maintains a right angle between the new direction of beam and that of the column, the column being pulled out of line by a more or less uncertain bending moment. With infinitely rigid columns there is a negative moment at the end equal to $\frac{1}{12}\ wl^2$, while the center positive moment is $\frac{1}{24}\ wl^2$. With flexible columns, the end moment is decreased and that at the center is increased, the sum always being $\frac{1}{8}\ wl^2$. With connections such as sketch (b), the length may be taken as the face-to-face distance between columns, and the bending moment developed in the column is the negative bending at the connection *plus* the product of the reaction by the half width of column. There remains only the question of the exact amount of this negative moment, and this depends upon the position of the point of inflection, which is governed by the relative stiffness of column and beam. Surely Mr. Godfrey and others will agree that only in extreme cases is it nearer to the column than is the center of the support in sketch (a), and that in all other cases sketch (b) will result in there being a considerable length of beam subjected to a negative bending moment. Mr. Godfrey should have limited his statement to the case of very flimsy columns carrying heavy beams.

There would be considerable danger in following the advice to design beams as though of simple span center to center of columns, when the rigid connections are used, since the column bending would be ignored. If the beams actually acted as designed, when this plan is followed, then the column would be thrown out of direction at the connection by an angle equal to that through which the end of the simple beam would change. So long as the change of shape in the column is accompanied by a bending moment, this same moment is deducted from the simple-beam moment at the center of span. This is a condition which we cannot ignore. Our designs are far more consistent throughout when we take into account all moments and stresses that are known to exist. By doing so the beam sections can be materially reduced.

When the point of inflection of a beam is as little as one-tenth the span from the support the positive moment at the center is less than $\frac{1}{12}\ wl^2$, and when the column is perfectly rigid, ideal fixed-end condition, the maximum negative moment is $\frac{1}{12}\ wl^2$. Only when the point of inflection is closer than one-tenth of the span to the support can the moment be greater than $\frac{2}{3}$ as much as in a simple beam. We might as well play fair with the structure and use beams only of sizes sufficient to resist the actual moments, using the saving thus effected to strengthen the columns against the bending inflicted upon them by rigid connections.

The foregoing must not be confused with the case of standard beam connections which make no provision for transmitting bending to columns. In the usual shallow standard details a very slight slipping of the web between the legs of connection angles permits the beam to act as though resting upon independent supports. Rigid connections are preferable to the standard ones in many structures where the stiffness of the building as a whole is important, but when they are used all resulting stresses should be taken into account and provided for.

Mr. Godfrey makes another statement which may be construed, and the writer so takes it, as meaning that like conditions of eccentric loading on each of several floors cause greater bending than does a single one of these loadings, yet he recognizes the fact that the bending carried into the column is divided between the sections above and below the connection. Obviously, the bendings at top and bottom of any story are in opposite directions. Besides, the column is held to position in plan by the framing of each floor, and any bending must be in the form of reversed curves, a complete cycle per story. The column, then, is under no worse bending when there is like eccentricity at each of a dozen successive floors than when at one floor only. Such eccentricity occurring only at alternate floors, or eccentricity of opposite kinds at adjacent floors, tends to combine the separate effects.

Mr. Godfrey is quite correct in condemning the connections of cantilever beams and brackets which he shows to be of improper detail. Also he champions the matter of tension rivets. Since a large part of the resistance of a riveted connection is due to the clamping of parts by the longitudinal shrinking of the rivet, we

might as well recognize the ability of rivets to take tension. In many cases, cited as causing tension on the rivets, probably the initial stress in the rivets is sufficient for the purpose and the external pull of the connected members merely reduces the original pressure between parts caused by the shrinking of rivets. However, the writer will suggest that, so far as possible, such details be made up so that only shop rivets be in tension while field rivets be arranged to take shear only.

In matters of this nature our concern should be to take into account all stresses resulting from the conditions which we impose upon the structure by the details of connections and the relative stiffness of members. Our attitude should be one of investigation of unknown factors and careful consideration of known facts rather than one of argument and the all-too-common unsound respect for precedent and the prestige of established practice. Argument never alters fact.

New Rochelle, N. Y. LEONARD C. JORDAN.

Sir—Mr. Godfrey's criticisms of errors in steel work details, in your issue of Oct. 16, 1919, are, as usual, well placed, and may be studied with much profit. However, in substituting the knee-angle connection for the seat-angle connection he is using a field connection in place of a shop connection, a weaker and costlier detail. The added strength may justify this step, but the point mentioned should be borne in mind.

He takes occasion to criticize the "ultratheorist" in rather caustic fashion. The distinction between the "theoretical" engineer and the "practical" engineer is annoying as well as useless. Whether a theoretical or practical man, you cannot evade natural laws. The theoretical engineer attempts to analyze and interpret them. Too often the practical man merely guesses that stresses do or do not exist. If refinements of analysis bring into play quantities too small for actual consideration, ignore them; the purpose of the investigation is to show whether they may or may not be ignored. It is not so long ago that the great theoretical investigator, St. Venant, pointed out to engineers the dangers involved in ignoring the shear in beams; practical engineers of that time did not use the shear. Take the example shown by Mr. Godfrey's Fig. 1. If the connection is made as he suggests and rigidity is sought and utilized, why not accept the result of the theory which says that the joint is then a fixed one and a bending moment introduced in the column? Any bending of the girder must necessarily affect the column, and can be quantitatively measured by the methods of analysis mentioned in the article. Like a concrete box section, the corners are fixed, and if such rigidity is overlooked the corner moments will crack the concrete.

The engineer should use all the tools in his possession. A practical engineer, with the word used in the right sense, eagerly scans the results of theoretical investigations, knowing them to be fruitful in many important and economical results. He only becomes "disgusted" to use Mr. Godfrey's term, when he discovers that valued truths are applied by the engineering profession about fifty years after their discovery by scientific students.

I speak at length on this point, because remarks by men like Mr. Godfrey have a strong reaction upon the technical schools and tend to hold in disrepute all theoretical investigations. Point out the errors in the theoretical studies and the fallacies in the hypotheses, but encourage at all times the careful, scientific analysis of engineering problems. That way lies the orderly progress of engineering design. GEORGE PAASWELL,

New York City. Consulting Engineer.

Highway Engineer Sees Need for Driller-Crusher-Tractor

Sir—I have received from J. W. McLaren, a road engineer in this state, a communication embodying his views concerning road construction, in which he says:

"Improvement in present types of road machinery is essential to meet successfully conditions in a rocky, mountainous country.

"An economical and efficient tractor is needed. Such a machine should be equipped with an air compressor for drilling rock to be removed from the roadway. (Perhaps a steam line for running Jap drills would be better.)

"It should be arranged to drive a stationary rock crusher at a quay, or to pull and drive a portable crusher for the loose stones along the road.

"In addition, there should be a large dumping wagon or truck, with loading device, for use in grading or graveling the road; this outfit to be operated by the tractor."

Mr. McLaren thinks that manufacturers of road-building machinery should be induced to develop something along the lines suggested. I believe there is considerable merit in his ideas, and should like to have suggestions from other experienced road engineers.

Keyser, W. Va. S. H. LEA,

County Engineer.

An Error in Field Tables

Sir—In the latest (18th) edition of Searles' "Field Engineering," revised by Prof. H. C. Ives, the logarithmic versed sine of 87°33′ is given as 9.881026 instead of 9.981026, which is the right value. This error, which of course is simply a misprint or an oversight and does not detract from the general excellence of the work, occurs in other previous editions, and probably did occur in the first, which was printed about 40 years ago. I found it some three months since, and notified the publishers, who no doubt have corrected the plates. However, it seems just that the many thousands of engineers who are using the book in its present form should be informed of the error, which is comparatively serious. ANTONIO LLANO.

Montclair, N. J.

Asks Aid in Swatting the Woodpecker

Sir—We have creosoted timber water tanks and a number of creosoted pine telegraph poles in northern Mississippi and Tennessee, which have been seriously damaged by woodpeckers, the birds having made holes almost the entire thickness. I am not able to say what becomes of the woodpeckers after they eat the creosote, but some of them continue their operations.

Can you or any of your readers furnish any suggestions as a means of combatting this pest?

Laurel, Miss. L. W. DUFFEE,

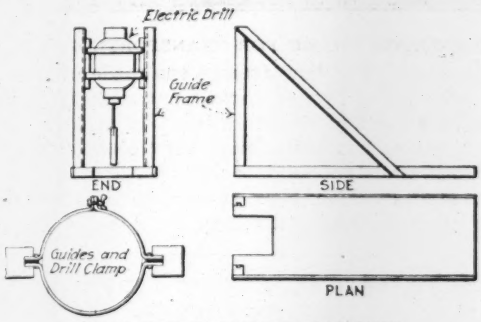
Chief Engineer, Mobile & Northern Railroad.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Boring Machine Improvised From Electric Drill

AN IMPROVISED guide frame and an electric drill hooped with two straps fitted to slide in the guides, as indicated by the drawing, proved to be a labor-saving tool in constructing centers and forms for the six-span arch bridge for the Illinois Central R.R., at Kankakee, Ill. The frame, except the plank base, was built of strap iron, the guides being square bars grooved. It



FIELD-BUILT BORING MACHINE

was an ordinary blacksmith-shop job. The drill was a small rotary electric drill fitted with wood augers. One man operated the outfit, and often bored, in timbers lying on a working platform, as many as 1200 holes a day. Separated from its guide frame and fittings, the drill proved highly useful about the framework during erection. The Gould Construction Co., Davenport, Iowa, was the contractor for the Kankakee bridge, with Alf. Lepard in charge.

Construction Air Line Anchored to Concrete Posts

COMPRESSED air up to 120-lb. maximum pressure is carried along the entire length of the nine-mile Queenston-Chippawa power canal now being built for the Ontario Hydro-electric Power Commission around Niagara Falls. The 10-in. line showed at first some tendency to jump or buckle under the extreme pressure, so the whole line has been carried on concrete anchor blocks spaced from 25 to 50 ft. apart. These blocks are 24x36 in. in plan and about 12 in. above ground and 12 in. below. The upper surface is cast with a semicylindrical groove in which the pipe rests. At each post the pipe is anchored down with a strap over the pipe and bolted into the concrete block.

Light Piledriver Operated by Derrick Without Extra Engine

BY F. W. EPPS

Bridge Engineer, Kansas Highway Commission, Topeka, Kan.

ONE HUNDRED sheet piles per day, driven 4 ft. at a cost of 2c. per foot, is the record of a light and inexpensive piledriver used at Kansas City, Mo. The driver is handled and operated easily by an ordinary boom derrick without the use of an extra engine, but is so constructed that it must be placed, guyed and braced for each pile.

The hammer is operated from the derrick lead line, while the boom is handled by the other line. The back brace, which may be seen in the view, consists of two 2 x 4-in. pieces, latticed so as to form a ladder. This is used when it is necessary to repair the hammer or the leads. Moving from one pile to the next position is accomplished quickly by slacking off the guys, raising the hammer until it engages a stop placed at the top of the leads, and then raising the entire driver by means of the derrick. When the leads are shifted to the new position, they are lowered to contact with the back bracing, and the guys are tightened. No extra engine is required for this driver, and no extra material except the leads and hammer. The outfit was designed by C. C. Clark, contractor, Topeka, Kan.

LIGHT PILEDRIVER IN POSITION FOR DRIVING

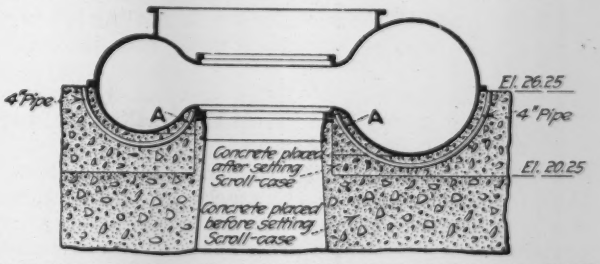
Curved Pipe Used To Prevent Air Pockets in Concreting Scroll Case

BY R. C. HARDMAN

Superintendent, Division of Municipal Engineering, The Panama Canal, Ancon, Canal Zone

IN THE construction of the extension to the Gatun hydro-electric station on the Panama Canal 4-in. black iron pipe was used satisfactorily for eliminating air pockets during the placing of concrete under the lower section of the scroll case for a 4500-kw. turbine unit.

As will be seen by the accompanying illustration, it would be practically an impossibility to place the concrete without having an accumulation of air at the points marked AA in the section unless some special means were taken to prevent it. At least, one could not be certain that such pockets did not exist in the



METHOD OF PLACING CONCRETE UNDER SCROLL CASE

finished work. Air pockets in such locations being especially undesirable, the method shown and described was adopted after consideration of several others.

Six lengths of 4-in. black iron pipe were bent to fit approximately the circumference of the scroll case at the sixth points in the horizontal plane. These were then placed as shown in the illustration and blocked in place with permanent blocking, with their inner ends a few inches below the case and their outer ends slightly below the level of the rough floor of the turbine pin. Concrete of usual consistency was then poured all around the case nearly to the level of its bottom, after which a very wet mixture was placed. This wet mixture was placed between the pipe bends and in but one segment at a time, so that the air would be forced out through the pipes on either side. As the air was forced out and the concrete flowed into position, the excess overflowed into the pipes and appeared at the outer ends at approximately the same level as the inner ends. The outer ends were then filled. The pouring was carried continuously around the scroll-case, so that after the first segment was poured the air and excess concrete must escape through the pipe ahead of the pouring. The upper ends of the pipes were concealed by the tile flooring with which the turbine pits were finished.

No originality is claimed for this method, but it is believed that it is not generally used and is as good a method of securing the desired results as is possible. The work was done by the forces of the Building Division of the Panama Canal, Hartley Rowe, resident engineer. The writer had charge of the work as acting superintendent.

Small Leaks Are Large Losses

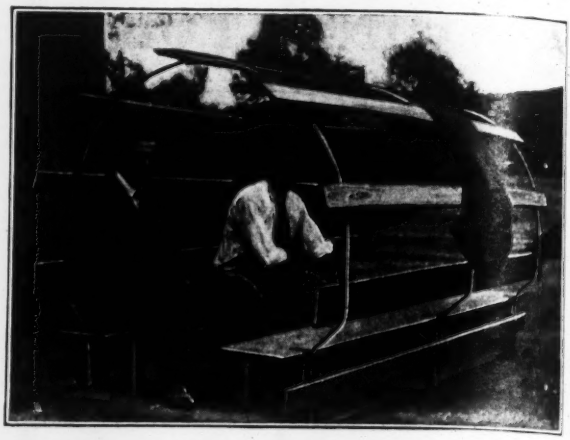
By E. Earl Glass
Los Angeles, Calif.

SMALL but constant losses are often the serious ones, and one cause of these is the common use of hauling equipment which distributes a part of every load along the route. Trucks, wagons and cars will become loose-jointed with continued use and abuse. Until they are overhauled the open joints should be stopped with canvas or burlap strips to prevent loss of sand, screenings or other fine materials. Strips may be nailed to the bottom edges of wooden dump-car doors to stop the spilling. Gondolas and steel dump cars are often received with several tons of stone or sand gone through a loose-fitting door or trap. Purchasers should insist that all openings be effectually stopped before loading so the carload will be delivered intact.

Motor-Truck Frame for Use in Hauling Men to and From Work

A MOTOR-TRUCK frame for use in hauling laborers to and from construction work and in transferring them from one part of the work to another is shown in the illustration. Being provided with a canvas covering, it may also be used as shelter for men upon road work during showers.

The frame is of light construction so it can be easily loaded or unloaded from the trucks by two or three men. This makes it possible to use it with the regular construction trucks which are employed for excavation and other hauling, the frame being removed on arrival at the work. The bow frames are made of ¾-in. iron, and inch lumber is used throughout with the exception of the framing under seats, where 2-in. material is used.



MOTOR-TRUCK FRAME FOR TRANSPORTING LABORERS

This device has been found very convenient by Guy W. Pinck, assistant engineer in charge of maintenance of the sixth division, New York State Highway Department, who originated the idea.

Submerged Pipelaying Experience in Shallow Water

By Theodore Warren Hacker
Resident Engineer for Norton, Bird & Whitman, Baltimore, Md.

SUBMERGED pipelaying across a series of water channels and intervening islands in the Potomac River is being conducted by novel methods for the new water-supply of Brunswick, Md. The crossing is at Knoxville, Md. The river at this point is 1925 ft. wide at low water, with a depth ranging from 12 in. to 4 ft. The water span is intercepted by five islands varying in width from 30 to 235 ft., making the widest water stretch 635 ft. The river bed is composed of conglomerate, varying from small gravel to stones 3 ft. in size, with frequent outcroppings of bedrock that is especially hard.

Universal cast-iron pipe 8 in. in diameter is being used, and was to have been laid in a 3-ft. trench and secured from movement by concrete anchors spaced at 30-ft. intervals. It was purposed to excavate trench by blasting, for which holes were to be driven to grade 18 in. apart for 100 ft., and loaded and bloated simultaneously. The holes were to be driven through the gravel with sand machines and through the rock with churn drills. After several trials of this method, it was found that the sand machines in penetrating the gravel would literally collapse under successive blows before a depth of 16 in. would be reached. Also, the rock proved to be so hard that progress with churn drills was so slow as to be too costly in time and money. Furthermore, the trench soon filled up with in-washing sand and gravel carried by the current, which runs from three to four miles an hour.

In the shallow water it was at first not deemed necessary to use a dam to check the flow and divert the water, but it was found to be necessary in order to keep the trench free from shifting material. The method worked successfully. To drill the rock it was

decided to use steam drills, and after much difficulty a two-ton boiler was rolled across the river and erected on an island from which steam lines extend both ways across the water.

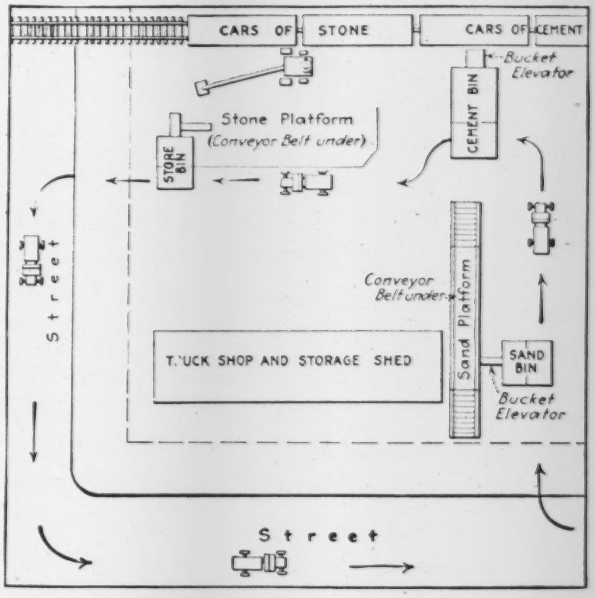
As it was imperative that water be delivered to Brunswick this year, after several attempts at a 3-ft. trench, which, it was estimated, would carry the work into cold weather, it was finally decided to lay the pipe in an 18-in. trench, place bags of concrete side by side across the pipe and refill the trench. In places where the pipe is laid in shallow trench it is raised and the material is raked out from underneath with hooks and rakes. A dam of excavated material on the downstream side of trench will be left 1 ft. above the river bed, which in time will build up to this level, making its own pipe cover.

The firm of Norton, Bird & Whitman, Baltimore, Md., is the engineer and the H. C. Brooks Co., Inc., Martinsburg, W. Va., is the contractor for this operation.

Central Loading Plant for Motor Truck Haulage

A COMPACT loading plant operated with a rather high output by a small force is being used with motor truck haulage of proportioned batches, on paving, at Spencer, Iowa. As described by W. L. Fahey, city engineer, in the *Concrete Highway Magazine*, a crane equipped with a clamshell unloads the crushed stone from gondola cars onto a wood box tunnel a little above ground level. The tunnel has gates operated from below by short-handled levers. These gates discharge onto a conveyor belt that carries the material to a bucket elevator to the top of the loading bin. From the bin the stone runs by gravity into a measuring box which is mechanically emptied into trucks.

Bulk cement is delivered to the cement bin in freight cars, which are unloaded by a power-driven scoop. The cement is carried to the top of the bin by bucket conveyors and is measured in a box before being emptied into the trucks. Sand is handled in much the same manner as the stone. As the source of supply is local, the contractors use their own five-ton motor trucks to haul it from the washing plant to the bin. The loaded trucks

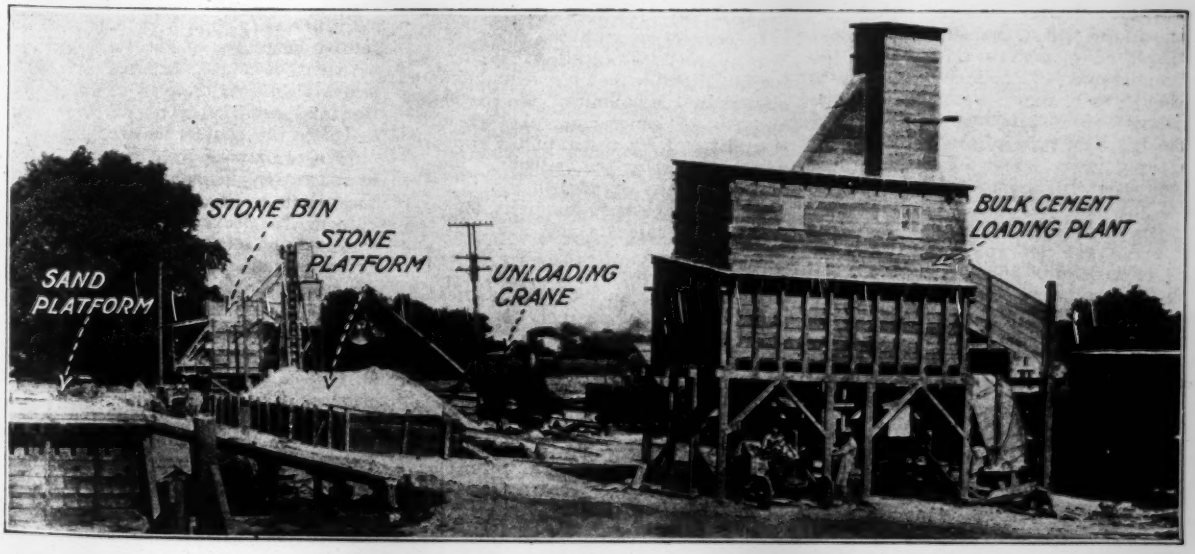


PATH OF MOTOR TRUCK THROUGH LOADING PLANT

run up an incline onto the platform, dump their loads, and the sand is carried by belt conveyor and bucket to the bin, from which it is measured into trucks. Electric motors operate the conveyors and elevators for each bin.

Materials are hauled from the loading plant to the mixer by a fleet of 10 standard Ford trucks with specially designed bodies. These first receive the correct amount of sand at the sand bin. They then pass under the cement bin, receive there the right amount of cement and proceed to the stone bin, where the correct volume of that material is loaded on top of the cement. For an average daily output of 1200 sq.yd. of 6-in. slab the loading plant crew consists of 1 foreman in charge and a mechanic, 2 men at the stone bin, 2 at the sand bin and 3 at the cement bin. Two machine operators handle the clamshell; there is a driver for each truck.

The contractors for this operation are J. S. McLaughlin & Sons, Red Oak, Iowa.



COMPACTLY ARRANGED LOADING PLANT FOR CONCRETE PAVING

NEWS OF THE WEEK

New York, November 27—December 4, 1919

State Departments in Massachusetts Reorganized

Under the provisions of the act providing for reorganization of the executive and administrative functions of the State of Massachusetts, the duties formerly performed by the various agencies are now vested in 16 departments. Of interest to engineers is the creation of the departments of public welfare, public health, public safety, public works, public utilities and the Metropolitan District Commission.

The Department of Public Welfare is under the supervision of a commissioner and an advisory board of six members, two of whom are women, all being appointed by the Governor, with the advice and consent of the Council. This department is charged with the study and investigation of problems relating to public interests, and to this end is organized into divisions of aid and relief, child guardianship and juvenile training.

The Department of Public Health consists of the department as formerly organized. It is under the supervision of a commissioner, who is in charge of the various divisions relating to the supervision of state hospitals, investigations and education.

The Department of Public Safety is charged with the supervision of boiler inspection, elevator regulations, fire prevention and the control of the district police.

The Department of Public Works comprises the former Highway Commission and the Commission on Waterways and Public Lands. It is organized as two divisions—a division of highways and a division of waterways and public lands. The department in general is under the supervision and control of a commissioner called the Commissioner of Public Works (salary, $7500) and four associate commissioners of public works (salaries $6000). The term of the commissioner is three years. Two of the associate commissioners serve for two years, two for one year. The commissioner appoints division heads, the registrar of motor vehicles and the various engineer-assistants and executive officers. He also approves all contracts and supervises all expenditures of the Department of Public Works. All rules and regulations under provisions of the existing law and pertaining to highways, public lands and automobiles shall be drafted by the commission and take effect when approved by the board.

The Department of Public Utilities is under the control of a commissioner and four associates appointed for

(*Concluded on page* 970)

This Week's News

This issue carries news current for the week ending Dec. 13. It is dated Nov. 27—Dec. 4, to preserve the sequence of numbers in the volume.

Conference of Founder Societies and A. A. E.

A joint conference of secretaries and other officials of the four leading national engineering societies and the secretary of the American Association of Engineers was held in New York on Dec. 8, with the object of discussing the possibility of coöperating in a proper apportionment of technical and professional work between the various organizations. It is understood that distinct progress was made toward concentrating technical work in the one group of organizations and professional work in the other.

Constructors Continue Coal Plea

Through its president, Ernest T. Trigg, the National Federation of Construction Industries, Dec. 4, again addressed the Central Coal Committee of the United States Railroad Administration on the subject of permitting certain classes of construction industries priority in coal during the strike situation. Representations had previously been made to the coal committee, but these were without result. Up to the present writing no further priorities had been granted.

M. I. T. Contracts With Industries

In connection with the drive of the Massachusetts Institute of Technology for $4,000,000 to match an equal amount offered by "Mr. Smith," the institute's anonymous benefactor, the executive committee of the institute has approved a plan whereby the industrial organizations of the country may retain the technical services of the institute. Such services include making available for five years its library and files, and conferences with its technical staff on problems pertaining to the business of the company seeking such service. Records of the qualifications, experience and special knowledge of the alumni are to be kept and made available. For the solution of special technical problems, the company will be advised as to where this service can best be obtained. Twenty-two organizations have already signed such contracts, $416,500 being obtained, in sums ranging from $500 to $25,000.

Make Plans To Accomplish Industrial Peace

President's Conference in Washington Formulates System To Obtain the Necessary Facts

(Washington Correspondence)

After a week of daily meetings held in executive session, President Wilson's new industrial conference has formulated a plan of procedure to obtain the necessary facts from which a definite program pointing toward industrial peace may be evolved.

Without any preconceived plan of attacking the task assigned them, the 16 members of the conference came to Washington at the invitation of the President. The problem that confronted them was the plan of procedure, and, unlike the members of the first conference, the members chose to deal with machinery and methods of handling and preventing labor disputes rather than deal with industrial principles.

Industrial disputes were divided by the conferees into the following groups: Federal, state and municipal employees; employees of public utilities, and employees of private industries. Whether employees coming under the first groups should be allowed to strike and what methods should be used to prevent such action, was the problem assigned to a special committee of the conference, which reported to the entire membership. It is the plan of the conference to deal similarly with the other groups of employees.

In order to expedite the collection of data upon which the conference will base its future decisions, Henry R. Seager, professor of economics, Columbia University, has been appointed executive secretary of the conference.

Other economic experts, who will assist Professor Seager in the collection and collation of facts, have been added to the conference staff.

"We are trying to arrange a permanent system, not a truce," said one of the members of the conference. "Machinery to prevent the necessity for strikes is as much an object of the conference as the machinery to stop strikes after they have started."

It is the plan of the conference to take a recess from Dec. 19 to Jan. 5. Before the recess, the conferees expect to have a definite outline of how they propose to handle and prevent labor disputes. After the recess, representative employers and employees will be called before the conference to present the facts of their respective sides.

The conference expects to utilize the data accumulated by Congressional

committees which have investigated labor disputes, data collected by Federal commissions, and the conclusions of the British and Canadian industrial conferences.

A tentative report will be published after sufficient data have been collected. Before publishing and presenting the final report to the President, the conference will take into consideration such criticism as will follow the publication of the preliminary report.

The members of the conference are W. B. Wilson, secretary of labor, chairman; Thomas W. Gregory, George W. Wickersham, Oscar S. Straus, F. W. Taussig, Samuel W. McCall, Herbert C. Hoover, Martin H. Glynn, H. C Stuart, W. O. Thompson, Julius Rosenwald, O. D. Young, H. J. Waters, Stanley King, Henry M. Robinson and Richard Hooker.

Engineering Council Makes Direct Appeal for Funds

On account of the increased cost of services, Engineering Council has issued a direct appeal to engineers of the country for personal contributions to aid in carrying on the activities of the National Service Committee headquarters in Washington.

It is pointed out that for the calendar year 1919 the member societies of Engineering Council have been able to provide $25,000, but that the council will need not less than $50,000 for the calendar year 1920, including the cost of the National Service Committee's headquarters in Washington. The statement is made, that aside from the possible appropriation of the member societies, not less than $30,000 will be needed.

The agreement is binding upon all work performed within the geographical limits of Greater New York and Long Island, and in such additional territory as is included in the provisions of existing trade agreements between the several trade associations of employers and the unions of their trades.

Urging Commerce Bodies To Indorse Jones-Reavis Bill

Engineers in the Chicago Association of Commerce are attempting to get that body to indorse the Jones-Reavis bill providing for a national Department of Public Works. In Denver the Civic and Commercial Association has had the matter presented to the board of directors through its mining bureau. A committee, of which some engineers are members, has the matter in hand.

Mississippi Proposes Road Bonds

In accordance with the highway convention held in Jackson, Miss., Oct. 23, the committees of attorneys and civil engineers met Nov. 13 at the office of the State Highway Commission to frame a bill authorizing the issue of $25,000,000 in road bonds. The bill will be considered by the Mississippi legislative session in January.

Railroads May Not Be Returned at Beginning of the Year

In the past week a decided change in opinion among officials and legislators in Washington has taken place with regard to the likelihood of the railroads being returned to their owners on the first of the year, in accordance with previous statements of Director General Hines, which followed opinions of the President. Due to the apparent impossibility of putting into effect an adequate legislative program by the first of the year, it is now considered by many that it will not be possible to return the roads to their owners at that time.

On Dec. 8 a vote on the Cummins bill in the Senate was halted by a parliamentary tangle, and it is now likely that another vote will not be possible for several days, to permit the bill to go to conference with the House, together with the Esch bill, already passed by the House.

In the meantime Director General Hines has completed his report to President Wilson on his recent conferences with Chairmen Cummins and Esch of the Senate and House Committees, respectively, but up to the present writing no intimation as to the nature of the report had been made public.

A conference of the six Governors of New England States, held in Boston Dec. 10 on invitation of Governor Coolidge of Massachusetts, adopted resolutions urging that financial assistance be given the New England railroads after they are returned to private control, and protesting against such return, under present conditions, as spelling disaster to these lines.

Canadian Waterway Men Favor St. Lawrence Improvement

The first Canadian waterways convention was held at Windsor, Ont., Nov. 18-19, 1919, with the object of effecting an organization to further the project of a great inland waterway from the Atlantic Ocean to Lake Superior. About 100 delegates were in attendance. E. L. Cousins, chief engineer of the Toronto Harbor Commission, said the channels in Toronto harbor have been deepened to 30 ft. to accommodate oceangoing vessels, in anticipation of the deepening of the St. Lawrence. C. P. Craig, Duluth, emphasized the need of greater transportation facilities for the Northwest. He would do all in his power to further the plan for making the Great Lakes the Mediterranean of the American continent. The Hon. Frank Keefer, Port Arthur, said the railways had failed to meet the problem of carrying the increased production of the Northwest, which could only be solved by deepening the St. Lawrence. This would make available more than 1,000,000 hp. for Ontario and New York. The project would involve the expenditure of $100,000,000, less than one-fifth of the cost of the Panama Canal, and would add 1000 miles to the coast line of the United States.

At the second day's session an organization was formed under the name of the Canadian Deep Waterways and Power Association, with the following officers: W. M. German, Welland, honorary president; Sir Adam Beck, London; and Mayor Thomas L. Church, Toronto, honorary vice-presidents; O. E. Fleming, Windsor, president; E. L. Cousins, Toronto, vice-president; F. M. Sclanders, Windsor, secretary-treasurer. Resolutions were adopted favoring the Great Lakes-Welland-St. Lawrence route to the ocean, and declaring that one of the objects of the association will be securing the development and deepening of the St. Lawrence waterways system along the lines on which the Great Lakes-St. Lawrence Tidewater Association is now working.

Standardize Stone Sizes

In order to facilitate the supply of crushed stone for road purposes, representatives of the highway departments of New York, New Jersey, Pennsylvania, Delaware and Maryland and of the crushed-stone producers of those states met in Philadelphia Nov. 18 and agreed on one standard size for stone. It was found that each state had a different standard, and that this situation resulted in slowing up production, due to the necessity of changing screens and stocking different sizes. The standard stone adopted was that passing a 2½-in. screen and retained on a ½-in. screen. The sizes between these meshes are to be the crusher run.

The meeting was called at the instance of Lieut. Col. W. D. Uhler, state highway engineer of Pennsylvania. Besides the representatives of the stone interests and Colonel Uhler, there were present W. G. Thompson, state highway engineer of New Jersey; Charles G. Upham, state highway engineer of Delaware; J. N. Mackall, state highway engineer of Maryland, and William Treadwell, representing Frederick Stuart Greene, state highway commissioner of New York.

Michigan Registration Board for Engineers and Architects

Appointments to the Michigan Board of Examiners of Architects, Engineers and Surveyors, created under the statute abstracted in *Engineering News-Record* of May 1, 1919, p. 889, are as follows: Emil Lorch, professor of architecture, University of Michigan, Ann Arbor; George L. Harvey, architect, Port Huron; Edward M. Walker, grade-separation engineer, Michigan Central R.R., Detroit; John A. Broad, Luce County road engineer, Newberry (trained as a mining engineer, but recently in road work); John J. Cox, Washtenaw County road engineer, Ann Arbor; Joseph A. Lardie, heating engineer, Pulte Plumbing & Heating Co., Grand Rapids; and George Jerome, civil engineer and surveyor, Detroit.

Would Make Construction Division Part of Public Works Dept.

A bulletin issued at Washington, Nov. 26, by the Engineers, Architects and Constructors' Conference on National Public Works contends that the Construction Division of the Army should be given an independent status outside the jurisdiction of the War Department, and that it should be eventually transferred to the proposed Department of Public Works. The reasons given for the proposed change are that the division's work is of a strictly noncombatant nature; that Army methods and Army experience are absolutely unnecessary to its proper functioning; and that its personnel consists almost entirely of civilian engineers and constructors.

According to the bulletin, the work of the Construction Division is not yet completed. The cantonments which were constructed during the war were of but temporary nature, and will not provide proper housing facilities for the permanent personnel of the regular Army. There are, the bulletin says, in the United States housing facilities of a permanent and usable nature for something less than 100,000 troops, and to care for the 300,000-odd men, which seems to be the minimum proposed by new Army legislation, it is necessary to provide additional facilities for some 200,000 men and officers. The bulletin states that Brig. Gen. R. C. Marshall, head of the Construction Division, estimates that its annual expenditure for some years to come will be not less than $100,000,000, and as that figure is said to exceed the total amount annually expended by the entire Quartermaster Corps during the period previous to 1917, the Construction Division should not operate as part of the Quartermaster Corps, or any other corps, but should be placed on a parity with them.

Final 27-Mile Stretch Is Paved on "Ridge Route" in Southern California

The "Ridge Route" between Bakersfield and Los Angeles was constructed by the California Highway Commission several years ago to cut 25 miles from the shortest route then existing between the two cities. The rather unusual features of the road were described in *Engineering Record* of Sept. 11, 1915, p. 322, and in the following issue editorial comment appeared on the policy of carrying out expensive construction through nontributary territory in order to get a short through route.

Decision to pave the entire ridge route was made last year, and the work was soon carried out on those sections along which traffic could be carried at one side while paving was under way. The central section, 27 miles in length, was, however, a formidable undertaking and was postponed until this autumn. During this part of the work all traffic had to take a detour that added 25 miles to the distance between terminals. Cement and steel had to be hauled 40 miles from the railroad, sand and gravel were hard to find along the line, and water was piped a total of 17 miles.

The paving has just been completed by highway commission forces for about $100,000 less, it is reported, than the lowest bid on the job and in less time than the limit set in the proposed contract.

The work was advanced from both ends simultaneously. The pavement is 20 ft. wide and has a minimum thickness of four inches.

Wyoming Plans Permanent State Good Roads Association

Considerable extension in the road-building program of Wyoming was indicated in a recent good roads conference held at Cheyenne. The proposal was made that Wyoming's next step in its highway development program be the voting of $25,000,000 worth of bonds, and the 300 delegates attending the conference were asked to give their support to the proposal.

From delegates to the conference, invited by Governor Carey, one man from each county was named to represent his county on a committee to map out a program leading to the establishment of a permanent good roads organization.

Pennsylvania's 1919 Road Contracts Total 649 Miles

Construction contracts awarded by the Pennsylvania State Highway Department from Jan. 1, 1919, to Nov. 30, 1919, inclusive, totaled 648.78 miles, the contract price for this work being $27,020,120.66. This figure includes contracts on state highways, county contracts, and state-aid contracts. The majority of the road contracted for in Pennsylvania during 1919 is of reinforced-concrete type, the remaining mileage being divided among bituminous concrete, brick, sheet asphalt, and plain concrete. The 486.21 miles of reinforced concrete contracted for aggregated $21,558,111.65, or an average cost of $44,358.25 per mile. All but 60 of the 648.78 miles contracted for were on primary and secondary highway systems, and state-aid on highway routes. On the primary system alone contracts were awarded for the construction of 512.61 miles of road, the contract price aggregating $21,514,212.83.

New Shipbuilding Program Proposed

Announcement has just been made by the United States Shipping Board that it is preparing plans for a new shipbuilding program of 1,000,000 deadweight tons carrying capacity of ships, distinct from the emergency war program, and that it will present these plans to Congress.

Col. W. D. Sohier Resigns From Mass. Highway Commission

Col. W. D. Sohier, for 11 years a member of the Massachusetts State Highway Commission, and for the past eight years chairman, recently tendered his resignation, pending the recent reorganization of the state's administrative departments.

In many respects, Colonel Sohier was the pioneer in this country in the framing of highway legislation pertaining to the regulation of traffic. He drafted the laws, now on the statute books of the State of Massachusetts, regulating the speed of automobiles and providing for the revocation of licenses of drivers convicted of certain offenses. He helped to administer the laws, and worked out a uniform automobile law which laid the foundation for the present system in Massachusetts.

Colonel Sohier early became a strong advocate of the good-roads movement and interested himself in methods and means for the development and standardization of state highways. Twenty years ago he began his investigations of the problem of the preservation of road surfaces against the wear and tear of automobile traffic. He experimented with calcium chloride, at that time in use to some extent in England, and later with oil products.

In 1908 Colonel Sohier became a member of the Massachusetts State Highway Commission, and at once started a scheme of providing efficient maintenance which has been followed out and has resulted in placing Massachusetts in the foremost ranks in this respect. Experimental sections were established—sand-oil sections in the soft, sandy district of Cape Cod, macadam sections in other parts of the state, and gravel and stone mixtures in heavily traveled parts. These experimental sections were noticed and studied by engineers from all parts of the country.

Early achievements of Colonel Sohier in this field of engineering were notable. Under his direction the first power spraying machine for distributing asphaltic materials on road surfaces was introduced; a machine to spray the heavier tar and asphalt products also was developed.

Under the supervision of Colonel Sohier a strong, efficient engineering department was developed, which has come to be recognized throughout the country as a leader in the field of highway engineering.

Colonel Sohier for many years past has been a prominent figure at national road conventions.

City Administrator Wanted

Under the new city charter of Akron, Ohio, which goes into effect on Jan. 1, 1920, the new council will appoint a chief administrator or city manager. The tentative salary for the office is $10,000 a year.

Bridge Project for Detroit River Being Studied

Investigations looking toward the construction of a bridge across the Detroit River to connect Detroit and Windsor, Canada, have just been started. Traffic and location studies are included. The work has been placed in the hands of Gustav Lindenthal, engineer of the Hell Gate arch bridge and designer of the proposed 3100-ft. Hudson River suspension bridge, as consulting engineer, and Charles E. Fowler as chief engineer for the joint boards of the American and Canadian companies which will undertake the construction.

While the need for better traffic connection across the river has been felt for years, the increase of traffic with the phenomenal growth of Detroit has made it imperative that modern means of carrying passengers and freight be provided soon. The great development of Windsor industrially is an important factor in this need. It is held that conditions call for a bridge of large capacity. Present views favor a double-deck structure to carry roadway traffic, street cars and steam trains. While the heavy vessel traffic of the Lakes must not be obstructed in any way, all navigation requirements can be met by either a cantilever or a suspension bridge of from 1800 to 2400 ft. span, depending on the final location adopted. These proportions will give the new structure rank among the greatest bridges of the world, though the cost, as estimated, is moderate. Local reports name figures between $20,000,000 and $30,000,000.

Water Works Association Elects Nominating Committee

The American Water Works Association has reported the result of the ballot for the nominating committee for the coming election of officers, as follows:

Charles R. Henderson, chairman; manager of the water company, Davenport, Ia.
District 1—Frank A. Barbour, consulting engineer, 1120 Tremont Temple, Boston.
District 2—Lyman P. Hapgood, superintendent water and light, Jamestown, N. Y.
District 3—James H. Long, City Hall, Camden, N. J.
District 4—Henry B. Morgan, manager Peoria water-works, Peoria, Ill.
District 5—Chester R. McFarland, secretary and manager Tampa water-works, Tampa, Fla.
District 6—F. W. Cappelen, city engineer, Minneapolis.

The officers to be elected are president, vice-president, treasurer, one trustee from district 2 and one trustee from district 5, the former district consisting of the State of New York, and the latter of the Southern states.

December Water Works Meeting

The New York Section of the American Water Works Association will hold a meeting at the Park Avenue Hotel, New York City, Dec. 17. It will be preceded by a luncheon. Francis H. Sherrerd will describe the 30-in. flexible joint line under the Hackensack River for the water-supply of Jersey City, N. J. The method of laying a 36-in. line across the Narrows from Brooklyn to Staten Island will be outlined by a representative of the New York Board of Water Supply. In addition to subaqueous water lines, there will also be discussed the suggested improvements in iron for pipe.

Lieut. Col. Keller, Former Deputy Chief Engineer, A. E. F., To Be Promoted

A communication from Washington, dated Dec. 7, contains the information that Lieut. Col. Charles Keller, until recently brigadier general and deputy chief engineer of the American Expeditionary Forces, has been nominated by the President for promotion to the rank of colonel, Corps of Engineers, U. S. A. The appointment is to be effective from Sept. 19, this year.

Colonel Keller was graduated from the Military Academy in the class of 1890. His experience in the service has been varied and valuable, and has covered most fields open to an engineer officer. From Dec. 27, 1898, to Mar. 15, 1903, he engaged in river and harbor work, first for one year at Portland, Me., under the immediate orders of Maj. S. W. Roessler; then until Apr. 28, 1901, he was secretary of the Missouri River Commission; and, following that assignment, was himself in charge of improvements of rivers and harbors on the east shore of Lake Michigan from Apr. 30, 1901, to Mar. 15, 1903. He served in the Philippine Islands from May 1, 1903, to Aug. 15, 1905, as engineer officer, Department of Mindanao, and as engineer of the Moro Province. Concurrently with his Philippine assignment he served from Apr. 1, 1903, to Sept. 15, 1905, in command of Co. K, First Battalion of Engineers, and from Aug. 13, 1905, to Sept. 15, 1905, commanded the battalion. From Sept. 20, 1905, until the beginning of preparations for the great war, he served as engineer of the 11th Lighthouse District and was in charge of the survey of the Northern and Northwestern lakes, with headquarters at Detroit, Mich.

With rank of brigadier general he joined the staff of Maj. Gen. W. C. Langfitt, chief engineer, A. E. F., as deputy, at the time preparations were being made for the great American offensives. During part of his service in the theater of operations he was assistant to the Chief Engineer at General Headquarters, acting as the latter's liaison and executive officer in relations with the Commander-in-Chief and the General Staff. For his services in France General Keller received among other decorations the French Legion of Honor.

Upon General Keller's return to the United States in the early summer of this year, he reverted to his pre-war rank of lieutenant colonel, and was assigned to duty as a member of the Board of Engineers for Rivers and Harbors.

Bureau of Standards' Current Budget

For the ensuing year the Bureau of Standards has asked Congress for nearly $3,000,000. Among the items of the estimates are: For continuation of the investigation of structural materials, $250,000 (an increase of $125,000 over the present appropriation); for investigation of fire-resisting properties of building materials and conditions under which they may be used most efficiently, and for the stabilization of types of appliances for fire prevention, $65,000 (an increase of $40,000); to study methods of measurements and technical processes used in the manufacture of brick, tile, terra cotta and other clay products, $50,000 (an increase of $30,000); for technical investigations, in coöperation with the industries, of fundamental problems involved in industrial development following the war, with a view to assisting in the permanent establishment of the new American industries developed during the war, $250,000 (an increase of $200,000).

American Contractors Invited to Bid on Colombian Tunnel

The Department of Antioquia, Republic of Colombia, South America, is planning the construction of a tunnel on the Antioquia Ry. through the La Quiebra Mountain. American contracting companies have been invited to submit bids, according to advices received by the Bureau of Foreign and Domestic Commerce. The tunnel will be approximately 12,250 feet long, and engineers of the Department of Antioquia have estimated that it will cost about $2,000,000.

More detailed information regarding the tunnel project may be obtained from the American Consular agent at Medellin. The Bureau of Foreign and Domestic Commerce will furnish the name of the engineer in charge, to inquiries referring to file No. 40802A.

Rapid Transit Engineers Organize

At a meeting of engineers engaged in rapid-transit construction in New York City, Dec. 8, a rapid-transit section of the American Association of Engineers was organized. One of the first undertakings of the section will be to induce the city Board of Estimate to adopt the budget formulated by the Transit Construction Commissioner, which provides increased compensation for the engineering staff.

Elect Officers on Detroit Examining Board

At a meeting of the Board of Examiners for the Registration of Architects, Engineers and Surveyors in the State of Michigan, held Nov. 8, 1919, the following officers were elected: George Jerome, Detroit, president; Prof. Emil Lorch, Ann Arbor, vice-president; John J. Cox, Ann Arbor, secretary.

State Departments in Massachusetts Reorganized

(*Concluded from page* 966)

terms of one, two, three, four and five years, respectively. The chairman of this board is designated by the Governor. This board has jurisdiction over different classes of corporations, and rules on the adoption of rates and policies of gas and electric corporations.

The Metropolitan District Commission controls the functions of the Metropolitan Sewerage and Water Board and the Metropolitan Park Board. It is under the supervision of a commissioner (salary $6000) and four associates (salaries $1000) appointed by the Governor with the advice and consent of the Council.

This act took effect Dec. 1. With the exception of the naming of Col. Richard K. Hale as an associate commissioner of public works, the appointments all went to lawyers and business men.

The following is a roster of the newly appointed officials:

Department of Public Works—Commissioner, John N. Cole, Andover; Division of Highways—Associate Commissioners, F. D. Kemp, Springfield; and J. W. Synan, Pittsfield; Division of Waterways and Public Lands—Associate Commissioners, J. B. Baxter, Milton; and R. K. Hale, Brookline.

Metropolitan District Commission—Commissioner, James A. Bailey, Arlington; associate commissioners, E. F. Whitney, Milton; Charles S. Baxter, Boston; F. G. Hall, Boston; W. H. Squire, Boston.

Work Resumed by American Committee on Electrolysis

Field investigations on the electrolysis of underground pipes and structures have been taken up by the American Committee on Electrolysis, working in coöperation with the United States Bureau of Standards. The work is being resumed where it was interrupted by the war and as it was left by the printed report of October, 1916.

The committee consists of 27 members, there being three each from the following nine organizations: American Institute of Electrical Engineers; American Gas Association; American Electric Railway Association; American Water Works Association; American Telephone & Telegraph Co.; National Electric Light Association; Natural Gas Association; American Railway Engineering Association; national Bureau of Standards. In the coöperative work being done with the United States Bureau of Standards each of the organizations named is represented by an expert chosen by it. The report made by the Bureau of Standards will be submitted to the general committee for approval.

The chairman of the main committee is Bion J. Arnold, consulting engineer, Chicago. The American Water Works Association is represented on the main committee by E. E. Minor, New Haven, Conn., and Nicholas S. Hill, Jr., and Alfred D. Flinn, New York City. This association has as its expert Prof. L. A. Hazeltine of Stevens Institute, Hoboken, N. J.

St. Louis Contractors Join A. G. C.

The several classes of contractors in St. Louis recently voted to amalgamate and become a chapter of the Associated General Contractors of America. The action was taken as a result of the visit to that city of the president and secretary of the Associated General Contractors.

Organize Eastern Ontario Hydro-Electric Municipal Union

The Eastern Ontario Hydro-Electric Municipal Union was recently organized at Brockville, Ont., by about 150 representatives of municipalities in eastern Ontario, from Kingston to the Quebec border, the object being to secure the development of water powers in that section and obtain the advantages of cheap electrical energy similar to those enjoyed in western Ontario. It was stated that the rates for electricity supplied by the Cedar Rapids Co. to municipalities in the East ranged from $45 to $70 per horsepower, while in western Ontario the rate was as low as $9 per horsepower. Resolutions were adopted urging the coöperation of the Federal and provincial Governments with the Hydro-Electric Power Commission to secure power development on the St. Lawrence between Morrisburg and Cornwall, and that one member of the Hydro-Electric Comission should be chosen from eastern Ontario. Mayor W. A. Lewis of Brockville was nominated for the position. The following officers were elected: President, W. B. Reynolds, Brockville; vice-presidents, Mayor Fetterby, Cornwall; R. F. Elliott, Kingston, and R. McEwan, Renfrew; secretary-treasurer, J. A. Johnston, Brockville.

Viaduct Cost Apportioned Among Eight Parties

Under an order issued by the Public Service Commission of Pennsylvania Nov. 20, the cost of the viaduct and bridge to be built across the Lehigh River at Bethlehem, Penn., is to be apportioned among eight parties. The total cost of the structure is estimated at $2,315,000. Of this sum the Counties of Northampton and Lehigh are each to pay $450,000; the Central R.R. of New Jersey and the Philadelphia & Reading R.R., jointly, $500,000; the Lehigh & New England R.R., $15,000; the Lehigh Valley Transit Co., $100,000; the City of Bethlehem, $405,000, and the Bethlehem Bridge Commission, $395,000. The last item has been raised by private contribution. Bids for construction of the viaduct are now being called for.

Civil Service Examinations

Canada.—Assistant in wood preservation, Forest Products Laboratory, Montreal, Department of the Interior, $1320 per year. File application with Civil Service Commission of Canada at Ottawa before Dec. 18.

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Town manager, $2400 per year, Dec. 16. To fill vacancy in Ordnance Department, Nitrate Plant No. 1, Muscle Shoals, Ala. File applications before Dec. 16.

Structural steel inspector, Naval Ordnance Plant, South Charleston, W. Va., $7.04 per diem, Dec. 23. File applications before Dec. 23.

Architectural and structural steel draftsman, Lighthouse Service, Key West, Fla., $1560 per year, Jan. 6. File application before Jan. 6.

Fire-prevention engineer, office of Director of Purchase and Storage, War Department, duty throughout United States, $2500 to $4000 per year, Jan. 13. File application before that date.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

BRIDGE BUILDERS' & STRUCTURAL SOCIETY, 50 Church St., New York City; Jan. 16, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS, 29 W. 39th St., New York City; Jan. 21-22, New York City.

ENGINEERING INSTITUTE OF CANADA; General Secretary, Fraser S Keith, 176 Mansfield St., Montreal; Jan. 27-29, Montreal.

AMERICAN ROAD BUILDERS' ASSOCIATION, 150 Nassau St., New York City; Feb. 9 '13, Louisville, Ky.

AMERICAN WOOD-PRESERVERS' ASSOCIATION; Secretary-Treasurer, F. J. Angier, Mt. Royal Station, Baltimore; Feb. 10-12, Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION; 210 South La Salle St., Chicago; Feb. 20-21, Chicago.

The Cleveland Engineering Society was addressed Dec. 9 by W. H. Weingar, precision-gage expert, Pratt & Whitney Co., Hartford, Conn., who spoke on the subject of "Manufacturing and Measuring in Millionths of an Inch." At the luncheon Dec. 5 John A Alburn, counsel for petitioners for the creation of a conservency district in Cuyahoga County, Ohio, spoke on "The Cuyahoga Valley Conservancy Plan." At the meeting Dec. 16 W. J.

Beck, director of research, American Rolling Mills Co., Middletown, Ohio, will read a paper on "Manufacture and Magnetic Testing of Electric Sheet."

A Billings, **Mont., Chapter of the American Association of Engineers** is in process of formation. A meeting in Billings Nov. 25 was attended by 22 engineers. The meeting was the result of a call issued by **F. D. Monty**, district engineer of the Montana State Highway Commission at Billings. Mr. Monty was elected temporary chairman, A. E. Lamb was elected temporary secretary, and steps were taken for the formation of a local chapter of the association.

The American Association of Engineers recently organized a section at the University of Kentucky, Lexington, with a number of members of the faculty and students in the engineering colleges as charter members. J. M. Angell, a traveling representative of Chicago, and also representing *Engineering and Contracting*, presented the purpose of the society to the students and faculty, and the following were among those enrolled: Prof. D. V. Terrell, head of the department of civil engineering; Prof. William A. Newman, Prof. W. J. Carroll and Prof. M. F. Melton. As soon as the necessary formalities can be complied with, the Lexington chapter will be organized.

The Oklahoma Chapter of the American Association of Engineers has been asked to name one representative to a civic advisory board of nine members which the city council has created to give it expert advice and assistance in administration matters.

The Louisiana Engineering Society held a regular meeting Dec. 8 at which Allen E. Washburn, Government engineer in charge of works at the mouth of the Mississippi River, presented a paper on "An Open Mouth for the Mississippi River."

The Baltimore Chapter, American Association of Engineers, announced that more than 200 applications for membership had been received during the first week of its membership campaign. At a business meeting Dec. 5 the following nominations were made: J. Harry Gross for president; G. A. M. Schaeffer, J. H. Adamson, F. P. J. Patenall and E. L. Gosnell for vice-presidents; Arthur T. Ihlang for secretary, and Miltor J. Ruark and B. L. Crozier for treasurer. A city and state rally of the association was held in the City Club quarters in the Munsey Bldg., Baltimore, Dec. 9, when a program of addresses arranged by Frank L. Riley was presented. Dr. John H. Gregory, professor of civil engineering, Johns Hopkins University, delivered a paper on "The Advancement of the Ethics of the Professional Engineer"; Maj. Ezra B. Whitman, consulting engineer, spoke on "Liaison Between Engineers and Contractors"; Otto G. Simonson, architect, defined "The Relationship Between the Architect and the Engineer"; Prof. J. B. Whitehead, dean of the Engineering School at Johns Hopkins University, presented a paper on "The Engineer as a Public Servant."

The Rochester, N. Y. Engineering Society was addressed by Edward G. Miner, president of the Pfaudler Co., at the weekly luncheon Dec. 9. Mr. Miner, who spent considerable time in England and Germany in the past year, spoke on "The European Situation."

The Engineers' Club of Philadelphia will be addressed by Commander William L. Cathcart, U. S. N. R. F., at the weekly luncheon Dec. 23. Commander Cathcart is to speak on "The Navy of the Future."

The Engineering Society of Buffalo held its third general meeting of the season Dec. 9. Ansley Wilcox spoke on the subject, "Buffalo's Opportunity." James H. Herron, Cleveland, addressed the meeting on "The Economic and Social Development of the Engineer."

The Canadian Electric Railways Association held its annual meeting at Montreal Dec. 3-4. The following officers were elected: Honorary president, Col. J. E. Hutchison, Montreal; honorary vice-president, Acton Burrows, Toronto; president, A. Gaboury, Montreal; vice-president, G. Gordon Gale, Hull, Que.; honorary secretary-treasurer, A. Eastman, Windsor.

The Indianapolis Chapter of the American Association of Engineers held a meeting Dec. 3 at which R. E. Tracy, bureau of municipal research, Chamber of Commerce of Indianapolis, spoke on the work of the bureau. A "traffic committee" was proposed for studying the local transit problem.

The Engineers' Society of St. Paul held a meeting Dec. 8, at which H. E. Mitchell, safety engineer, Oliver Iron Mining Co., Eveleth, Minn., spoke on safety engineering.

PERSONAL NOTES

MAX L. CUNNINGHAM has resigned as state highway engineer of Oklahoma.

H. B. BUSHNELL has resigned as maintenance engineer of the Illinois State Highway Department, to join the staff of the Western Wheeled Scraper Company.

J. N. SMITH has been appointed county engineer, Logan County, West Virginia, succeeding J. W. MCLAREN, who has entered the office of the division road engineer at Huntington.

LEWIS H. DELANY has severed his connection with FRANK L. WILCOX, consulting engineers, St. Louis, and has become superintendent of construction for the W. E. Wood Co. of Detroit, on additions to the Dort Motor Car Co. plant in Flint, Mich.

W. F. COCKE has resigned as highway engineer of Florida, to accept the position of deputy highway commissioner of Virginia.

FRED TARRANT, district engineer of the Illinois State Highway Department, has been promoted to the position of maintenance engineer, succeeding H. B. BUSHNELL, resigned, as noted elsewhere.

KENNETH EVANS, assistant construction engineer of the Illinois State Highway Department, has been promoted to the position of district engineer, succeeding FRED TARRANT, whose promotion is noted above.

PROF. J. E. KICKHAM has resigned as professor of structural engineering at the Iowa State College and as consulting bridge engineer for the Iowa State Highway Department, and has become bridge engineer in the South Dakota highway department.

E. W. CANNING, formerly a superintendent of construction, STONE & WEBSTER Co., Boston, has become associated with JOHN B. LEARY, formerly of the staff of FORD, BUCK & SHELDON, INC., in the building contracting business, with headquarters in New London, Conn.

FRANK E. CAVE has left the service of the St. Paul Union Depot Co. to enter the bridge department of the South Dakota State Highway Commission.

C. S. CHENEY, San Francisco, secretary of the City Plan Commission of California and city plan consultant for Portland, Ore., has been appointed city planning engineer for Spokane.

JAMES H. POLHEMUS, general manager, Coos Bay Shipbuilding Co., Marshfield, Ore., has been appointed general manager and engineer of the Port of Portland, Ore., and will take office Jan. 1.

H. FRANK DORR has been elected county engineer, Cambria County, Pennsylvania, with headquarters at Ebensburg. Mr. Dorr was previously engineer of two townships in Cambria County.

J. M. MEADE, who for the past 43 years has been connected with the engineering department of the Atchison, Topeka & Santa Fé Ry., for many years serving as division engineer, has opened an office in Topeka, Kan., to engage in private practice, specializing in railroad work.

IRA TAYLOR, formerly assistant drainage engineer, Kansas State Engineering Department, has been appointed resident engineer on Federal-aid road work in Mitchell County, Kansas, with headquarters at Beloit.

F. H. FREETO, who since his discharge from the Army has been con-

nected with the testing department of the Kansas Agricultural College, has been appointed resident engineer of Federal-aid roads in Labette County, Kansas.

DAVID V. BLAIR, Bilivia, Ky., who was formerly connected with the engineering department of the Consolidation Coal Co. at Jenkins, has become field manager of the Elkhorn Mining Corporation at Fleming.

W. RANSOM HOLBROOK, Mayking, Ky., has entered the engineering department of the Louisville & Nashville R.R., with headquarters at Ravenna.

COL. RICHARD K. HALE, who before the war was a member of the firm of RICHARDSON & HALE, has been appointed a member of the Public Works Commission of Massachusetts. For a number of years he was editor of the *Journal of the New England Water Works Association.*

GEORGE I. HOWARD, who for many years was deputy city engineer of Schenectady, N. Y., under HENRY C. ALLEN and THOMAS W. WOOLEY, has been appointed city engineer.

W. W. PEARSE, architect and superintendent of buildings for the City of Toronto for some years, has been appointed business administrator and secretary-treasurer of the Toronto Board of Education. Mr. Pearse was born and educated in Canada, but was for many years connected with engineering work in New York City, being successively with Levering & Garrigues, the Hinkle Iron Co., the American Bridge Co., and the Radley Steel Construction Co. For the last-named concern he was engineer and later vice president.

PAUL H. NORCROSS will continue the work of the firm of the SOLOMON-NORCROSS Co., consulting engineers, Atlanta, Ga., which was dissolved Jan. 1, 1918, when Col. Gabriel R. Solomon became identified with the Construction Division of the Army. At that time current contracts were carried to completion by Mr. Norcross, under the old firm name, and now that such work has been completed Mr. Norcross will continue his work as consulting engineer, with headquarters in Atlanta.

T. F. BRIGHT has been appointed county engineer, Norton County, Kansas.

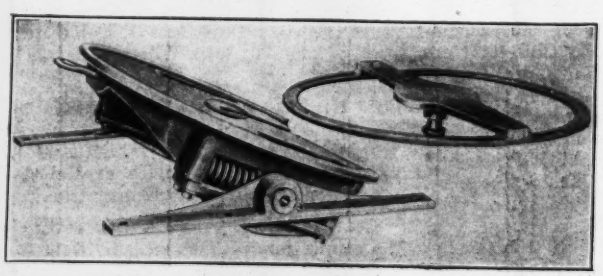
OBITUARY

STEPHEN PEARSON BROWN, who until last May was vice president and general manager of the Ford, Bacon & Davis Corporation, New York City, died in Dover, Me., Dec. 7. He had been associated with the corporation since 1917, and had been in charge of the construction of a carbo-coal plant for the International Coal Products Corporation, built for the United States Government in southwestern Virginia. He was born in Dover, Me., in 1877, and was graduated from the Massachusetts Institute of Technology in 1900. From then until 1903 he was junior partner in the firm of Collier & Brown, consulting engineers, Atlanta, Ga., and later became associated with the United Engineering & Contracting Co., New York City, with which he served as resident engineer and principal assistant engineer in charge of construction. He was finally made general superintendent of all work west of Fifth Ave. on the crosstown section of the Pennsylvania R.R. tunnel. In 1908 and 1909 Mr. Brown was in Europe, where he made an extended investigation of European tunnel practice. For three years following he was chief engineer of the Tidewater Building Co., New York City, and in 1912 became chief engineer of the Mount Royal Tunnel & Terminal Co., Ltd., Montreal, and managing engineer for Mackenzie, Mann & Co., Ltd. He had charge of both the design and construction of the Canadian Northern terminal development in Montreal, including a double-track tunnel over three miles long and freight and passenger terminals involving an expenditure of about $15,000,000. He was a contributor to the technical press and was the author of the description of the Mount Royal tunnel work which appeared in *Engineering Record* of June 28, 1913, p. 708. In 1917 he became associated with the Ford, Bacon & Davis Corporation. He resigned last May to take up private business in Dover, Me.

FRANK H. KIRCHNER, president of the Kirchner Construction Co., Cincinnati, died in that city Dec. 7, at the age of 60.

Device Lifts and Couples Trailer

A new automatic "fifth-wheel" device which renders unnecessary the use of jacks for lifting the front end of a semi-trailer to connect to and disconnect from the truck has been invented by C. H. Martin, Springfield, Mass. The device combines in one unit an automatic coupler and a cam for raising the front end of the semi-trailer. It will soon be placed on the market by the Marti Rocking Fifth Wheel Co., Springfield, Mass.



DEVICE FOR CONNECTING TRAILER TO TRUCK

Compressed Gas Manufacturers Will Meet in January

The Compressed Gas Manufacturers' Association will hold its seventh annual convention at Rumford Hall, Chemists' Club, 52 E. 41st St., New York City, Jan. 12. Otto S. King, Standard Oxygen Co., New York City, is secretary.

BUSINESS NOTES

THE MCCLINTIC-MARSHALL PRODUCTS CO., Pittsburgh, has established a contracting office in Havana, Cuba, Obrapia y San Ignacio, P. O. Box 2429, in charge of Charles A. Pesant, for the sale of steel construction for bridges, buildings and storage tanks for oil and molasses.

THE LINK-BELT CO., Chicago, is building a 70 x 400-ft. addition to the furnace buildings of the Belmont foundry in Indianapolis, to provide greater facilities for the production of "Malleable Vim Chains."

THE VAN DORN ELECTRIC TOOL CO., Cleveland, has just completed a four-story building with 30,000 additional feet of floor space.

FAIRBANKS, MORSE & CO., Chicago, are to build in Beloit, Wis., a new foundry which will contain approximately 490,000 sq.ft. of floor space.

THE READING IRON CO., Reading, Penn., is being reorganized under the direction of L. E. Thomas, the newly elected president, who was formerly vice president and general manager, Birdsboro Steel Foundry & Machine Co.

W. Woodward Williams, the general manager of the company, was general manager of A. M. Byers Co., Pittsburgh, for several years. Craig Geddis, advertising manager, was formerly connected with the sales and publicity departments of the National Tube Co. Edgar F. Blessing has been appointed metallurgical engineer, and W. E. Dunham production engineer. Mr. Blessing was formerly connected with the Doehler Die Casting Co., Brooklyn, N. Y., and Mr. Dunham was service manager for the A. M. Byers Co. The company has purchased the George B. Lessig Co. plant at Pottstown, Penn. Branch offices for district sales representatives have been established in Philadelphia, New York, Pittsburgh, Chicago, Cincinnati and Dallas.